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EXPERIMENT STATION
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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
RANGE MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
FOREST SURVEY
FOREST INFLUENCES

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FOREST RESEARCH

BI-MONTHLY REPORT

February 1, 1939

FOREST RESEARCH

BI-MONTHLY REPORT

February 1, 1939.

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GENERAL

DO WE HAVE TOO MANY EGGS IN ONE BASKET?

R. K. LeBarron

Lake States Forest Experiment Station

The recent catastrophes which struck experimental forests - the fire and flood which damaged the San Dimas in California, and the hurricane that wrought such havoc at Gale River, Bartlett, Keene, Fox, and Harvard Forests in New England - illustrate a type of risk inherent in the policy of concentrating research on small areas. The danger is, in fact, so great that the question may be asked: Does the policy of experimental forests need rethinking?

The writer had the experience of witnessing a tornado that wrecked the Kawishiwi Experimental Area on the Superior Forest in 1932. Fortunately, no great amount of experimental cuttings had been established prior to this storm. Since then we have, with the aid of miscellaneous projects, attempted to clean up and restore the Kawishiwi, but it has been a tedious and thankless task.

It is possible that we might lose, in the long run, more plots from destructive agencies if the experiments were scattered widely, than if they were concentrated on a few experimental forests, but the effects are different. The loss of an occasional plot, here and there, does not upset projects or financial arrangements, but when a whole experimental forest goes, it may suddenly wipe out the results of years of the most painstaking effort.

Furthermore, we have an obligation to restore damaged experimental forests, but when scattered plots are destroyed, we can gracefully withdraw and select new locations.

These observations raise, in an acute manner, the whole question of conducting forest research on limited areas or scattering the plots widely in a more representative fashion. Perhaps it is time to reconsider the policy. Certainly we are in a better position now to do this than we were 10 years ago when most of the experimental forests were founded.

Admittedly, experimental forests have some weaknesses, such as the danger of major losses, which has just been described. They are not entirely representative because they are few and far between. Furthermore, they have tended to divert our time, thought, and financial resources to the development and care of physical improvements like houses, landscaping, and fences.

However, experimental forests have had the effect of making research more realistic because they put research workers into the forest, squarely up against local specific problems. Although not fully representative of all forest types and conditions, research conducted upon experimental forests can and has been used in the development of principles applicable far beyond their boundaries.

Experimental forests have been called "windows into the future", and as such they serve as a guide and inspiration to forest managers. They make possible inexpensive but well rounded and instructive show-me trips for both laymen and foresters.

It seems evident that experimental forests are a success from the standpoint of increasing the effectiveness of research but, on the other hand, the burden of maintaining physical improvements, costing much in time and money, is a real problem which should not be ignored. For all these reasons, it appears that the time is ripe for a reconsideration of the whole policy of experimental forests. This is presented in the hope that it will elicit reactions from other Experiment Stations.

Lake States

Seminar Program. Following the practice initiated in 1937, the Station again this winter is holding a series of seminars to bring together for informative discussions the faculty and graduate students of the Division of Forestry and our own staff. Members of the State Conservation Department often attend.

The regular procedure is for a member of the Station staff to relate the results of a project upon which he has been working and then have a round table discussion. Since the meetings are held at 4:00 p.m., when mental activity is likely to be below par, tea or coffee is served. The usual attendance is thirty to forty persons, which demonstrates the popularity of the program.

So far this year the following subjects have been covered: Food habits of Minnesota deer, by Aldous; Grants-in-aid to local governments, by Moser; Effect of fertilizers on drought resistance, by Shirley; the AAA and farm forestry, by Holcomb; How the Forest Survey has changed the forestry picture, by Cunningham; Cruising methods for farm woods, by Gevorkiantz.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory

The large number of species and the rugged topography complicate compilation of data for North Carolina Unit #4. Such factors as site, volume per acre, species composition, and accessibility are of much greater importance here than in the eastern units. The large volume of blight-killed chestnut, still standing, also requires special consideration.

Depletion

The compilation of the 1937 lumber production data for North Carolina was completed in January. Nearly 3,300 sawmills operated in the State in this year, producing more than 1½ billion board feet of lumber. Comparison of these figures with those for other States as given by the Forest Survey and the Census indicates that North Carolina has more sawmills than any other State in the Union and that it is one of the leading States in the South in lumber production.

The cooperative project with the Bureau of the Census, whereby this Station will receive and edit the 1938 lumber production forms was begun in January. Considerable time of the Survey staff will be required to work out the procedure for this project and editing the forms received. The returns are coming in very slowly. Although forms were mailed to more than 3,000 sawmill operators early in January, only 300 returns had been received by the first of February.

California

Type Map Project. A new low in field mapping on the Vegetation Type Survey was reached in 1938, when only 932,000 acres (1.29 percent of project area) were covered. The reason - drastic personnel cuts. Most of the work was done in the Nevada area, left over from 1937. Thanks to the WPA, however, greater progress was made in the office, where work equivalent to 2,256,000 acres (3.12 percent of project area) was completed. Publication of the maps that have been in the mill for the past several years has progressed smoothly, if not with any great speed; three quadrangles being

completed. Four new sheets were worked up and submitted to Washington for preliminary drafting. As of December 31, 1938, the status of the project was as follows:

Operation	Acres	Percent
Total area of project	72,100,000	100.00
Field mapping completed	32,006,000	44.39
Office work completed	23,060,000	31.98
Quadrangles published (18)	5,139,000	7.13
Quadrangles in process of publication(4)	1,830,000	2.54
Additional quadrangles submitted for drafting work prior to publication (8)	1,980,000	2.74

Utilizing a request for advice and assistance by the local Soil Conservation Service office to further test the applicability of aerial photographs for Forest Survey purposes, two members of the Survey staff spent October and November on the S.C.S. Placerville Project Area. In previous work on the Lakeport Quadrangle it had been found that significant differences in timber-stand conditions could easily be recognized on the photographs. However, it was also found that many of the areas thus delineated would not fit into any of the hitherto-used stand classes because they were made up of, not one, but two or more different classes. To arbitrarily force them into one or another class would be to introduce considerable variation in their composition, as regards both the major element and its associates. Such a procedure would also add to the problem of attaining consistency between mappers.

To meet these difficulties a flexible system was devised whereby each area is readily classified on its own merits from the photographs, and variation within each class is reduced to a minimum. Dunning's tree classes provide the basis for age-class differentiation as follows:

Map Symbol	Broad Age Class Stand Elements	Dunning's Tree Class Equivalents
1	Reproduction (Up to 4 in. DBH)	- -
2	Thrifty trees (Under sawlog size)	1, 2, 6
3	Thrifty trees (Sawlog size)	1, 2, 6 (Under 150 years)
4	Mature trees	3, 4 (150-300 years)
5	Overmature trees	5 (Over 300 years)

The application of the system is simple. With the aid of a stereoscope, boundaries shown in the photographs are drawn around areas of generally uniform stand pattern and each area so delineated is then carefully scrutinized to determine the broad age-class elements present. The appropriate symbols, representing those elements which form approximately 20 percent or more of the crown cover as viewed through the stereoscope, are inserted in the order of relative area dominance. Thus an area designated (51) indicates an overmature stand with reproduction, while (15) represents reproduction with more or less scattered overmature trees, the aggregate crown canopy of the latter covering less area than that of the reproduction. Similarly (32) represents a thrifty stand with sawlog-sized trees the more abundant, while in a (23) stand such trees are less abundant than those under sawlog size. While the boundaries segregating the various stand conditions can be delineated in the office and the age class content in most cases determined from the photographs, field verification of the latter is necessary, particularly with classes (2) and (3). For example, stand designated in the office as (3) were often found to be (32) or (23), although their exterior boundaries had invariably been drawn correctly. To further increase the usefulness of this classification, provision is made to designate any age class composed of defective or low quality unmerchantable trees, such as are frequently left in logging. This is done by over-lining the age class affected. Thus (351) represents a stand in which the overmature trees are predominantly unmerchantable in character.

A new approach for mapping stocking was also employed on the Placerville Survey. After futile attempts to segregate well, medium, and poorly stocked stands on the basis of the customary percentage divisions it was decided to look for some other basis in the photographs themselves. It was impossible to find the 70 percent line to outline well stocked stands or the 40 percent line to segregate medium stocked from poorly stocked. If one person thought he found these lines, another would locate them quite differently; thus, consistency was out of the question.

In studying the photographs under the stereoscope it was found that the presence or absence of the following cover elements as exposed to the sky could be readily observed: Conifers (C), Hardwoods (H), Shrubs (S), Grass or other herbaceous cover (G), areas devoid of cover, such as rock or bare soil (B). These elements were then grouped as follows:

Trees (T) = (C) + (H)
All other elements (O) = (S) + (G) + (B)

With this as a basis (T) areas, those where trees alone were dominant, other cover elements being negligible or absent, and (O) areas, where trees were absent or negligible, were outlined on the photographs. From the area remaining, where both trees (T) and

other elements (O) were present in combination, all areas (TO) where trees occupied more ground space than all other elements combined, were in turn delineated, leaving residue areas (OT), where trees occupied the least ground space. It was then assumed that the resulting (T), (TO), (OT), and (O) areas essentially represented, so far as trees were concerned, well-stocked, medium-stocked, poorly-stocked, and unstocked areas respectively. If stocking of the conifer element alone is desired, the hardwoods (H) can be included with the other elements, and (C), (CO), (OC), and (O) areas can be as easily delineated. Similarly, in treeless areas, density of the Shrub (S) element can be determined by a delineation of (S), (SO), (OS), and (O) areas.

The above methods of classifying age-class composition and stand densities would seem to have much to commend. They are simple and workable. The element of personal judgment is in large measure eliminated, so consistency is easily attained. The classifications are readily defined, easily understood, and obviously useful.

Lake States

Growth and Yield

In the Station seminar January 12, Cunningham quoted a few figures from recent Forest Survey releases to illustrate a general topic, "To what extent has the Forest Survey changed the forestry picture in the country?". The average acre of forest in the Lake States supports 1100 board feet of merchantable saw timber. The average in the South appears to have about 2,085 feet, while the Pacific Northwest (Douglas fir) reports 21,600 feet. The differences in annual growth in well-stocked stands in the three regions are not as great as sometimes stated, but, on account of the large deforested area in the Lake States, the general average for all areas shows an unfavorable comparison for this region:

	Annual Growth Per Acre	
	Bd. Ft.	Cu. Ft.
Lake States	35	19
South	107	28
Douglas-fir region	88	34

Growth and drain in terms of cubic feet are in approximate equilibrium for the South and Lake States. No data were at hand for the Northwest. In board feet there is a slight excess of drain

in the Lake States and South and a 4 to 1 excess in the Northwest where there is a large volume of old-growth timber. Each region, of course, has certain critical areas where overcutting is most pronounced.

Direct comparisons with situations portrayed by older estimates are difficult, however, due to changes in regional boundaries, changes in standards and interpretations. The survey at least is going to permit foresters to get down to brass tacks on many questions of public policy.

Pacific Northwest

Reports

Ponderosa Pine Region. Rough draft of the depletion, growth and forest industries sections of the regional report is nearing completion. Further analysis of the saw-timber volume by types and diameter classes is being made. Volume in residual stands on cut-over lands also will be given special consideration.

The average stand per acre of the pure ponderosa pine stands (type 20.5, more than 80 percent ponderosa pine) was 12,000 board feet, log scale, per acre in Oregon and 8,900 board feet per acre in Washington. The ponderosa pine stands (type 20, 50 percent to 80 percent ponderosa pine) averaged 11,800 board feet per acre in Oregon and 8,800 board feet per acre in Washington. The stands on cut-over lands in which majority of volume is in 12 to 22-inch trees (type 34-21) averaged 2,700 board feet per acre in Oregon and 1,900 per acre in Washington.

Southern

Reports

Cruikshank's report, "Forest Resources of Northeast Texas," was completed and mailed out. The report points out that while agriculture is important in the area, between 1924 and 1937 there was a shrinkage of approximately 576,000 acres devoted to cotton growing. The report also emphasizes that opportunity for increasing employment on a large scale by producing agricultural crops seems remote, unless new crops can be developed to utilize even more intensively the land formerly planted to cotton. Timber production, however, offers some opportunity to modify the adverse economic trend owing to a possible decline in oil-field activity and decreased cotton production. Then too, the proposed newsprint pulp mill at Lufkin, Texas, may provide some employment and an increased demand for forest products. To meet these requirements, or

even to maintain the present growing stock, it is absolutely essential that improved forestry practices be immediately undertaken, Otherwise, the forest resource will steadily decrease, leaving the people more and more dependent upon a shrinking agriculture, and a temporary petroleum industry.

Forest lands in this unit must be made more productive by:

(1) An intensification and extension of the present system of fire protection. Although about 70 percent of the forest land was protected in 1936, most of the forest has suffered from periodic burning, and is greatly understocked. Fire protection is one practical method of increasing the growing stock in this area, where all the increment is needed to maintain the present forest industries. Reserving a portion of the increment to build up the growing stock is desirable, but in this unit, if not done gradually it would reduce industrial activity and thereby add to the existing unemployment.

(2) An extension program including demonstration forests emphasizing the best practices of farm forestry is essential, because 52 percent of the forest land is in farm ownership.

(3) A planting program to reforest the 700,000 acres of idle and abandoned agricultural land. The State could assist by furnishing nursery stock at nominal cost.

(4) Additional State and Federal participation to provide funds or legislation for increased protection against fire and trespass, cheap credit for sustained-yield enterprises, assurance of equitable taxation, and adequate research program, and the establishment of freight rates on lumber comparable with those in adjacent Southern States.

NEW PUBLIC DOMAIN

Lake States

Proposed Legislation. The final public hearing of the Minnesota Legislative Interim Commission on Forestry and Tax-Delinquent Lands was held in St. Paul on December 6 and 7. The Commission's final report, in which the Station has actively participated, even to the extent of assisting in the drafting of proposed legislation, has been prepared and submitted to the Legislature. The report recommends definite legislative action to provide for (1) classification of tax-forfeited lands, (2) transfer of a portion of such lands to the State for conservation purposes, (3) sharing of revenues from tax-reverted lands with local governments, (4) assumption by the State of a share of local debts in State conservation areas, (5) a rural zoning enabling act, (6) a land exchange act in accordance with the constitutional amendment adopted in November, 1938,

authorizing exchange of state school and swamp lands with private owners and the Federal Government, (7) changes in laws governing timber sales on State lands to facilitate small sales, and (8) marking rough timber in transit with registered brands as a means of controlling timber trespass.

Although the title to tax-reverted lands rests nominally in the State, the laws now being drafted in accordance with these recommendations will place the chief responsibility for classification and disposal of tax-forfeited lands in the county boards, with the State agencies acting in an advisory capacity.

Pacific Northwest

A series of meetings with representatives of the Bureau of Agricultural Economics and private forest industries in which Wilson participated resulted in general agreement on sound principles which should underlie a rural zoning measure for Oregon. These principles are: (1) Rural zoning law should be aimed to facilitate the solution of distinctly rural problems in the interests of the public health, safety, and general welfare of the people; (2) rural zoning law should provide for reasonable variations and changes in zones, rules and regulations to meet varying and changing economic conditions; (3) zones should follow the pattern of economic land use developed by an analysis of physical and economic factors; (4) public hearings upon adequate notice should be held on proposed zoning plans; (5) adoption and enforcement of rural zoning regulations should be by county governmental authorities; (6) nonconforming uses and occupancies should be prohibited, providing, however, that nonconforming lawful uses and occupancies in existence at the time of zoning regulations are adopted may continue except where voluntarily discontinued for a reasonable period after adoption; (7) a Board of Adjustment should be provided with authority to hear and decide appeals on errors in administering the regulations and to authorize such variance from any regulation as will not be contrary to public interest and as will do substantial justice and avoid unnecessary hardship; (8) any interested party may appeal from a decision of the Board of Adjustment to a court of competent jurisdiction.

In the tentative classification of lands in Clatsop County, Oregon, an undertaking of the BAE in which the State College, this Station, and the Regional Office cooperated, strikingly greater attention was paid to soils, topography, climate, cover and home ranch commensurability in indicating a possible use of cut-over lands for grazing. Admitting that needed accurate measuring sticks are lacking but with the aid of general observation, it appears that in this county the ultimate acreage of such grazing lands will be estimated at best to be approximately 42,000 acres guardedly placed

in several preference classes and concentrated in the Nehalem River Valley within a reasonably compact area. Most of the lands under consideration have been forfeited to the county for unpaid taxes or deeded directly to the county by owners who have declared their intent to abandon them.

The desirability of classifying cut-over lands within the Fish-hawk Creek basin in Columbia and Clatsop Counties as forest lands and incorporating them within a public forest was given further consideration by the State Schools of Forestry and Agriculture, a work in which the Station and Regional Office have been cooperating during the past year. Most of the lands are tax-forfeited and abandoned.

The taxation work program was reviewed by R. C. Hall in December, during his week's visit to the Station.

Work was continued on the Stevens County, Washington, study of Local Government Adaption and Reorganization. Good use is being made of assessed value data gathered by the WPA under a project sponsored jointly with the State Planning Council.

The Washington deferred timber tax bill was reviewed in conferences with its sponsors, members of the State Tax Commission. In Oregon the legislature will again have before it a bill providing for the State assessment of timber property. The Station recognizes both of these bills as steps in the right direction.

PRIVATE FORESTRY

Central States

Farm Woodlands

Stand and stock tables have been prepared for the farm woodlands of three townships located in three northwestern Ohio counties. These tables show the stands by three species groups as well as by diameter classes and broader size groups. The stands are expressed in numbers of trees, basal area, utilizable volumes in cubic feet for material of firewood size and larger and in board feet for the sawlog portion of those trees 13 inches or larger. Stand and stock diagrams built on a standard plan are in preparation for greater ease in comparison and contrast.

Within the stands the growth for better-stocked farm woodlands on sawlog trees is about 60 cubic feet of material per year for firewood size and larger. In sawlogs the annual growth is

about 270 board feet. The Woodlands more sparsely stocked are growing at slower rates.

Lake States

Farm Woodlands

Recently this Station has proposed some changes in the regulations governing AAA benefit payments for forestry practices which, it is believed, will encourage farmers to greatly improve the management of their woods.

It is proposed, first, to permit classification of ungrazed wood lots as soil-conserving areas. Under the AAA program, a farmer is paid for carrying out stated soil-conserving or soil-building practices such as planting legumes, fertilizing, and planting shelterbelts, but the total payment cannot exceed fifty cents for each acre of soil-conserving area on the farm. Consequently, the inclusion of farm woods in the soil-conserving areas would materially increase the payments which farmers could earn under this phase of the AAA program.

The second recommendation is to broaden the scope and place a priority on forestry practices for which farmers would receive payments. The desired forest practices are listed in the following order of priority: (1) fencing, (2) planting, (3) elimination of competing vegetation, and (4) stand improvement. No payments should be made for work of lower priority done when work of higher priority considered necessary by the local advisors, remains undone.

Financial Aspects

Collection of the field data for the mill study at the Ford Motor Company's small modern band mill in the model town of Alberta, Wisconsin, has been completed.

The purposes of the study are to develop further the use of log grades as a means of determining timber quality in standing trees and logs, and to find the quality and value of returns from selection cuttings of different kinds. It is hoped that the results of the study will convince the Ford Motor Company that selective cutting and sustained-yield management should be practiced on their timber holdings in this locality.

The Forest Products Laboratory, State and Private Forestry Division of Region 9, and this Station are participating in the project.

Northeast

Financial Aspects

Forest Service studies of lumber production costs and values have shown that ordinarily selective logging will increase the operator's average margin for profit per M board feet. On lumbering operations two major factors are involved; the cut contains a higher proportion of large trees that can be handled more efficiently; and these trees produce a higher percentage of the better grades of lumber. On pulpwood operations in the Northeast, the latter item is not a consideration as unfortunately no premium is paid according to quality of the wood. An analysis of pulpwood operations in second-growth spruce and fir stands indicates that, just as in producing sawlogs, tree size is an extremely important item affecting all phases of production. However, as the operating costs for trees of a given size increased when a portion of the stand is reserved, the average costs per cord will be noticeably lower on a selective basis only if the general run of tree sizes is somewhat higher than would be obtained in making a clear-cutting. However, the increased cost of partial cutting will be more than offset by an increase of one inch in average size of trees cut. Good silvicultural practice in second-growth spruce and fir stands, aside from discriminating against fir, ordinarily involves the removal of the larger trees together with many smaller merchantable stems that are competing with the better trees of about the same size. If the small trees occur in considerable numbers and can be profitably utilized, the average costs per cord on a selection basis may well exceed those obtained in clear-cutting. From a forest and land management standpoint, a selective cutting is certainly justified in these young stands, but it does not necessarily follow that average operating costs per cord will be reduced.

Pacific Northwest

Financial Aspects

Selective Timber Management in Douglas Fir. At the request of the Weyerhaeuser Timber Company Brandstrom has been keeping in close touch with the study work now being conducted by the aforementioned company on a 1500-acre area near Mineral, Washington. On this area, which contains some 70 million feet of fine old-growth timber, mainly Douglas fir, with hemlock and cedar in mixture, the company intends in the near future to conduct intensive study and experimentation of various degrees of selective cutting. The area has already been mapped and at the present time a detailed quality cruise is being made, in which all trees more than 26 inches in diameter are being tagged, numbered, and log-graded.

Brandstrom and the two Regional Office members, Messrs. Wright and Flynn, of the "logging machinery committee", report encouraging progress on the desigh of the new type logging tractor. A small-scale model of the proposed tractor has been constructed by the engineering staff of the Forest Service Equipment Laboratory and tested for tipping action, weight distribution, etc., both with and without leads, with the result that the proposed design is now considered safe and sound from an engineering standpoint.

Brandstrom has recently completed a translation of an article entitled "Rational Forest Management" by Uno Wallmo, in the January, 1939, issue of the Swedish forestry journal "Skogen". The article describes 40 years of experience in the application of a system of intensive selective cutting which, with recognized differences in age of forest, rate of growth, and basis of value, is not dissimilar to that proposed by Kirkland and Brandstrom in the bulletin "Selective Timber Management in the Douglas Fir Region."

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

California

Behavior

Size of fuel Particle as a Factor Influencing Rate of Spread. The results of the several hundred miniature fires which were burned during the field season of 1937 under improvised laboratory conditions to determine how moisture content and fuel compactness influence the rate of spread of fire in undecomposed pine needles, show that the rate of spread decreases in proportion to the rise in moisture content and that for any given moisture content the rate of spread increases with declining compactness of the fuel bed. Wind and slope were zero, and variables such as shape and size, which are inherent attributes of fuel, were eliminated by the use of needles of a single species for most of the fires. Compactness is expressed in terms of V/S (voids/surface) which is the ratio of the total voids to the total surface area of the fuel particles in the test bed. To illustrate: If the volume of a given bed is 1000 cubic inches and contains 700 grams of pine needles with a furface area of 15 square inches per gram and with a density of 7 grams per cubic inch, then the V/S ratio is calculated in this manner:

$$\frac{V}{S} = \frac{1000 - 700/7}{700 \times 15} = \frac{900}{10500} = 0.086$$

The range of V/S values attained for beds of ponderosa pine needles was from 0.05 to 0.18.

Additional physical properties which it seemed important to consider were size and shape of the fuel particles, and of these, the effect of size on rate of spread with moisture content constant was selected for investigation.

To attain uniformity in chemical and physical properties, except size, one kind of material had to be selected. This material was ponderosa pine sapwood, and it was obtained in veneer sheets 1/5, 1/8, 1/16, and 1/28 of an inch thick. These were ripped into sticks square in cross-section so that four sizes were available for four series of fires, one for each stick size, over a range of V/S values from 0.16 to 0.36. It was possible to control the V/S ratio by using sticks of different lengths, for decreased length gives lower values of this variable.

The burning procedure was essentially that adopted in the earlier work. The fuel was scattered by hand in beds 36 inches square by 2 inches deep, and the rate of spread of the fires was obtained by measuring the time from the instant of ignition of the celluloid "primer" (a piece of celluloid 2 inches square folded and inserted vertically at the starting point) to the moment the fire had reached a diameter of 18 inches. Moisture content samples were taken from the edges of the beds during the short interval between the preparation of the beds and burning.

The data were plotted as four curves, one for each size series, of rate of spread over V/S ratio, with size as the parameter. The curve values are given in Table 1.

Table 1. Rate of spread of miniature fires in inches per minute as a function of size and V/S ratio.

Size Inches	Reciprocal of Size	V/S Ratio .16	.20	.24	.28	.32	.36
1/5	5	1.3	1.4	1.6	1.8	2.0	2.2
1/8	8.3	2.0	2.2	2.4	2.6	2.8	3.0
1/16	15.9	3.8	4.3	4.6	4.9	5.2	5.6
1/28	27.4	6.2	7.0	7.6	8.0	8.4	8.6

Table 1 shows that if rate of spread is plotted against the reciprocal of size with V/S as the parameter, a family of straight-line curves is obtained. The general formula for these curves is

$$R = M\left(\frac{1}{t}\right) + C$$

where R = rate of spread in inches per minute, M = slope, t = size in inches, and C = the "R-intercept". This equation, as well as the plotted curves, shows that rate of spread of the fires studied is inversely proportional to the size of the fuel particles. A general equation which includes the V/S ratio is:

$$R = 0.396 \left(\frac{1}{t}\right) (V/S)0.262 + 2.32 (V/S) - 0.27$$

The correlation index is high for both the free-hand curves and for the curves calculated from the general equation, being 0.996 and 0.944 respectively. It would be unwise to make broad generalizations as to the effect of size of fuel on the rate of spread of natural fires on this small number of cases, namely, 38 fires. Accordingly, the study is being continued to cover a greater range of both fuel sizes and V/S ratios. Further information in this field of investigation may at least be expected to contribute to the knowledge of the importance of fuel as a variable in the rate of spread of fires and may afford a sound basis for field classification of fuel types.

Northeastern

Control

Slash conditions created in the woodlands of New England by the hurricane of last September constitute not only a serious fire hazard endangering both human life and forest cover, but a menace to the productive capacity of woodlands for years to come. Reductions of the excessive accumulation of slash is essential to the accomplishment of two important objectives: (1) the reduction of fire hazards, (2) the restoration of windthrown areas to a productive condition.

The United States Forest Service and the State Forestry Departments in the hurricane area have embarked on an extensive fire hazard reduction, protection, and suppression program. As a stimulus to woodland owners to undertake the work of rehabilitating their woodlands, the Agricultural Adjustment Administration, under a special program, will make payments to woodland owners at the rate of four dollars per acre, up to fifteen acres per farm. This program in no way duplicates the work being undertaken by Federal and State agencies; instead it supplements the work of these agencies.

The Station took a major part in the formulation of the practices which form the basis for payment under the AAA emergency woodland program. These practices aim to reduce fire hazard, promote desirable productive conditions, minimize the danger from destructive insects, and clear the land sufficiently to encourage

natural reproduction or make the area suitable for planting. Before payment will be allowed for performing the practices, the woodland owners must obtain prior approval from authorized ACP supervisors and committeemen.

In order to get the program organized and under way, and a personnel properly trained on methods and procedure, a series of meetings were held at various points in each of the New England states under the leadership of the extension foresters. In attendance were state and county ACP committeemen, county supervisors, county agents, and representatives of the Timber Salvage Administration. Research men took an active part in several of these meetings, assisting in proper interpretation and application of the measures. Woodland owners are displaying an active interest in the program. Unquestionably the AAA emergency woodland program will go a long way toward reducing fire hazard and restoring damaged woodlands to more productive condition.

Northern Rocky Mountain

Control

Since returning from leave, Hayes has been engaged primarily in further polishing of his manuscript concerning fire danger factors by altitude and aspect, which is intended for publication in the Monthly Weather Review. Cline and Naiman continued checking all fire danger measurements made at 134 stations on 17 national forests during 1938. McKeever is entering fire danger data on the annual fire report code sheets.

Many investigators have shown that the percent of actual rainfall caught by an open, exposed rain gage varies inversely with wind velocity, while a gage exposed with its orifice flush with the surrounding ground surface is unaffected by wind. Since large differences in wind velocity existed between the six altitude and aspect stations, it was believed that the 1935 and 1936 measurements made with Forest Service rain gages in standard exposure were not sufficiently accurate to make comparisons between sites. Therefore, in the spring of 1937 "stereopluviometers" were designed to be exposed in pits with their orifices set flush with the surface of the sloping hillside and the gage in a vertical position and surrounded by a 6 x 6 foot square, splash-preventing mat. Six gages were made, one each for north and south aspect stations at 2700, 3800, and 5500 feet elevation.

The results of two seasons' measurements show that more rain was caught by the stereopluviometer than the Forest Service gage at all stations but the greatest increase in catch occurred on the

windy south aspects. The Forest Service gages caught more rain on north aspects than on south by 4.7 percent at 2700 feet, 9.3 percent at 3800 feet, and 15.1 percent at 5500 feet elevation. The stereopluviometer caught more rain on north aspects than on south by but 2.4 percent at 2700 feet, and 0.2 percent at 3800 feet, while the south side caught 1.1 percent more than the north side at 5500 feet. On south aspects we find the Forest Service gage at 5500 feet caught but 7.3 percent more rain than at 2700 feet, while the stereopluviometer caught 27.2 percent more. From these few data it is obvious that correct rainfall relationships between sites having different exposures to wind cannot be obtained from open, exposed rain gages, nor can the correct quantity be caught on any windy site by gages in open exposure.

Pacific Northwest

Control

A procedure for applying the methods of detection planning proposed by the Station was agreed upon after several conferences with the Regional Forester's office of Fire Control. It was decided that the final selection of lookout locations for each forest should be made at a round-table conference of Regional Office representatives, technicians, representatives of the forest concerned, and cooperating agencies protecting adjacent land. The conference would review technical data concerning each location and preliminary proposals for the final system submitted by detection planning technicians. This procedure was first proposed and used in Region 5. Morris prepared detailed instructions for making maps of probable fire occurrence and for ranking lookout locations according to the amount of new visible area weighted by fuel type and risk which each lookout point will add to the total coverage for the given ranger district.

Fire danger station records from 100 ranger districts for 1938 were summarized by Wilkinson to compare the fire danger by years, months, forests, and districts. For the region as a whole the fire danger averaged 3.7 (on a scale of 0 to 7) which was 0.4 greater than last year. The forest averages ranged from 2.94 on the Mt. Baker in north-western Washington to 4.15 on the Siskiyou in southwestern Oregon. July was the worst month for forests west of the Cascade Range but August was the worst for most of those east of the Cascades.

The instructions on fire danger rating in the R-6 Fire Control Handbook have been completely rewritten and the record forms have been improved.

From an analysis of the variation in wind velocity readings at mountain peak or ridge top fire danger stations Morris found that 8 such stations per ranger district would be required in northeastern Washington in order to obtain an average of the highest daily recorded wind velocity for the peaks and ridges that would have an error of ± 5 miles only 1 percent of the time. The 9 districts studied each have from 2 to 5 peak stations at present.

Southern

Behavior

Fire Danger Meter for Grass Fuels in the Longleaf-Slash Pine type. At a meeting held in December at the Harrison Experimental Forest, the results of the Station's work on rate of spread and resistance to control in grassy fuels were presented to representatives of Region 8, including the Texas, Kisatchie, Mississippi, Alabama, Florida, and South Carolina National Forests.

Charts were shown which provided a means of estimating fire perimeter, rate of spread, and rate of line construction. Estimates of perimeter and rate of spread are based on easily measurable fuel and weather factors; estimates of rate of line construction are based on man power, equipment, and rate of spread. It was brought out in the meeting that to use these charts it is necessary to have an estimate of discovery time since time of origin is seldom if ever known and because of the high rate of spread of fire in grass.

From these charts, as an illustration of their potential use, other charts were prepared to show the man power required to control a fire for various perimeters at arrival, rates of spread, and control-time standards. Provided that the rate of line construction is known, any tactics may be assumed. Theestimated man power required for control depends, of course, on the particular tactics assumed. It is hoped that these charts can be tested by several National Forests in Region 8 during the 1939 spring fire season.

FOREST GENETICS

California

Segregation

Identification of Ponderosa and Jeffrey Pine Seedlings. The Institute's 1937 progeny test, which is now two years old, contains progenies of both ponderosa and Jeffrey pines. These two

species are so similar that under some conditions it is very difficult to tell them apart. Since both are quite variable and occur together over a considerable portion of the El Dorado transect of the Sierra Nevada, where the seeds for this progeny test were gathered, it seemed entirely possible that there might have been a few incorrect species determinations by the field crews at the time of tagging the seed-trees and collecting the cones.

In order to test this matter, and to locate possible natural hybrids, a species determination was recently made for all of the 6,561 plots in the experimental nursery. According to seed-tree determinations, 6,269 of these plots were ponderosa pine and among these were scattered at random 292 plots of Jeffrey. The numerical plot labels gave no clue as to the species. Yet every one of the 6,561 plots was identified in the nursery as Ponderosa or Jeffrey in exact agreement with the previous field determinations.

This complete agreement between so large a number of field and nursery determinations is gratifying in so difficult a case as these species present. Knowledge as to what characters will be determinative at different ages and what the form of ultimate generalization will be must await the observation of these nursery seedlings through the changes from juvenile to mature form.

Since little has been written about the juvenile identification of these species, it may prove helpful to summarize here the characters that were used in the recent studies of two-year old seedlings.

Character	Ponderosa Pine	Jeffrey pine
Color of needles	Dark, slightly yellowish green, without bloom.	Light bluish green, with a whitish or bluish bloom.
Color of buds	Usually a fairly smooth light orange brown, but sometimes quite whitish with some of this kind of brown.	Usually white, or white with some dark chocolate brown; the color markings are such that the individual scales stand out more prominently than on Ponderosa.
Surface of buds	Buds sometimes smooth, but more often roughened by the bending back of some of the scales.	Buds nearly always quite smooth & not appreciably roughened by the bending back of bud scales.
Resin on buds	Resin, usually in the form of dried flakes, seems to be present in practically all cases, though in varying amounts.	Buds seem to be without resin in any amount.

All of the plots and the vast majority of the individual seedlings were readily classified as Ponderosa or Jeffrey on the above bases. However, a few of the Jeffrey plots contained individual seedlings that were somewhat intermediate in nature, or that combined characters in unusual ways. These seedlings may have resulted from the natural crossing of Jeffrey ovulate flowers with ponderosa pollen, and they will be preserved for future observations.

Causes of Plant Vigor. Hybrid vigor and individual vigor of plants have long been a puzzle to the botanist. Various theories have been advanced to account for vigor, the latest being that of Ashby 1/ who, since 1930, has presented considerable evidence to indicate that hybrid vigor may be due to the size of the meristem in the dormant embryo. He found that the actual growth rate of the heterolic hybrid was no greater than that of the most vigorous parent but that the larger initial meristem resulted in a larger plant at any time of the growth period. If generally true, this principle would have great significance in plant breeding work, and for this reason it was decided to test the hypothesis in Pinus. Various methods were tried and discarded until X-ray photography was tried. It was learned that a short exposure X-ray photograph of intact pine seeds gave an image of the embryo sufficiently clear for measuring. Several years must elapse before conclusive results can be obtained but the method gives promise of considerable usefulness in other ways such as segregating partially filled hybrid seeds which should be used, from empty seeds which should be discarded, and analysis of endosperm formation and embryo development in seeds that are desired for planting.

Mineral Nutrition. Investigations dealing with mineral nutrition of ponderosa pine have been continued. The amount of phosphorus in needles of seedlings grown in the greenhouse from seed obtained at different elevations was found to be as follows:

Elevation, thousand feet:	0-1	1-2	2-3	3-4	4-5	5-6	6-7
Phosphorus, Mgs / gram in oven-dry needles	1.51	1.46	1.34	1.35	1.51	1.71	1.70

This table indicates that pines growing from seed gathered at an elevation between 2,000 and 3,000 feet contain the least amount of phosphorus.

1/ Ashby, E. 1930. Annals Bot. 44:457-476.
1932 " " 46:1007-1032
1937 " " N.S.1:11-41.

The subjoining table shows the amount of phosphorus in the top soil and also in the plant indicator (sunflower) of the three elevations in the Sierra Nevada where the Institute transect nurseries are located.

Locality	Elevation, Feet	Phosphorus in soil p.p.m.	Phosphorus in sunflower plants. Mgs per gram of oven-dry leaves and stems
Bossi's Ranch	800	.99	2.41
Institute	2750	.10	1.12
Pyramid R.S.	5600	1.5	2.86

In other words the amount of phosphorus both in the soil and in the plants is the lowest at the Institute. It is believed that investigations of this kind, if continued, will help to differentiate between environment and heredity in studies of pines.

Northeastern

Breeding

From the controlled breeding work of 1937 a total of 1,242 seedlings have been grown. This group contains seedlings resulting from self-pollination, close-pollination, inter-specific pollination, and intra-specific pollination in the following genera: Acer, Betula, Liriodendron, Magnolia, Quercus, and Ulmus. A considerable amount of seed was also obtained in 1938 from controlled pollinations in these genera, as well as Carpinus, Ostrya, Pinus, and Tilia. This picture of results may need to be modified somewhat by the possibilities of parthenogenesis in some species of Betula. The selection of outstanding individuals, from the standpoint of form, vigor, wood quality, disease resistance, et cetera, as well as fundamental inheritance studies, will in most cases be delayed for some time because of the small size of the seedlings.

MENSURATION

California

Tree Studies

Adequate volume tables are needed for cruising and experimental work in the redwood region just as they are needed in other forest regions. A redwood volume table was prepared about

1900, but as it is based on the actual utilization of one company at one long-past time, its application is quite limited. Variation from tree to tree in utilization possibilities and variation in utilization standards between companies, as well as changes from time to time, make tables with several definite standards of utilization desirable.

Redwood volume tables have some differences from the usual volume tables. The large and variable butt swell of redwoods and the very irregular fluting at the base make the usual d.b.h. measurements unsatisfactory. A diameter 20 feet above the ground on the upper side of the tree has therefore been selected for the basal diameter. The customary average ground line cannot be readily located accurately for large trees on steep ground, as there may be as much as 10 to 15 feet difference between the upper and lower ground lines. Measurement of points on the trunk not reached from the ground are possible by means of a combination monocular with mill scale and Abney level which has been devised by redwood cruisers.

Schumacher and Girard have pointed out that in many species the top diameter utilized follows more closely a fixed percentage of the basal diameter rather than a constant diameter. On the operation of one company in the redwoods it was found that the average top d.i.b. utilized for trees over 30 inches in diameter fluctuated up and down between 60 and 70 percent of the 20-foot d.i.b. while the top d.i.b. of trees below 30 inches went up to 80 percent. Although there is some variation in top diameter expressed as a percentage of basal diameter, it is much more constant than top diameter in inches and for this reason it was felt that use of top diameter as a percentage of basal diameters was the best means of providing definite standards of utilization.

In order to provide for different degrees of utilization and different top conditions of individual trees, tables are being prepared, based upon top diameters inside bark equal to 50 percent, 60 percent, 70 percent, 80 percent and 90 percent, respectively, of the diameter inside bark at 20 feet above the ground.

Data from 710 trees have been collected along with various timing studies on the operations of three companies. Equations (using the logarithmic method devised by Schumacher) for volumes for the five different top ratios have been worked out and the equations for three top diameter ratios put into alinement chart form for greater ease in calculating volumes for the tables. The other two equations will be converted into alinement charts shortly.

The equation, multiple correlation coefficient and the standard error of estimate are shown in the accompanying table.

D.I.B. Top ratio	Regression equation	RI.23	SI.23		No.
			:Log.	Percent	
50	X_1=1.9569X_2+.9772X_3-.8351	.9972	.034	-7.5-+8.1	561
60	X_1=1.9671X_2+1.0011X_3-.6714	.9979	.029	-6.5-+6.9	603
70	X_1=2.0147X_2+.9599X_3-.3560	.9985	.024	-5.4-+5.7	658
80	X_1=2.0567X_2+.9150X_3+.0818	.9988	.020	-4.5-+4.7	699
90	X_1=2.0679X_2+.8662X_3+.7883	.9968	.033	-7.3-+7.8	710

X_1 = Log. of (V-v) V = Gross volume v = volume of log having diameter equal to d and length of h.

X_2 = Log. of (D-d) D = 20 ft. d.i.b. d = top d.i.b.

X_3 = Log. of (H-h) H = merchantable height above a 3.5 ft. stump. h = 16.5 feet.

RI.23 = Multiple correlation coefficient. SI.23 = Standard error of estimate.

As the trees were not selected at random the statistical measures given indicate only the correlation and variation of the trees measured.

The relationship between estimated values and original values of X_1 indicated that the relationship was not strictly linear. For trees over 25 inches the departure from linearity was not great, but for small trees it became quite pronounced. Correction for this was made by adjusting the volume axis of the alinement chart by the method outlined by Bruce and Schumacher (Forest Mensuration - Bruce and Schumacher.).

Linear regression of bark thickness on d.i.b. at 20 feet height is used in preparing tables based on diameter outside bark at 20 feet.

Additional measurements are to be collected in order to get better coverage of the whole region. These additional trees will not be used to change the equations but will be used in connection with present measurement to correct or adjust the original alinement charts in much the same way as assumed base charts are corrected.

Central States

Tree Studies

Black Walnut. Revision of the first draft of the black walnut manuscript is in progress. It is planned to segregate the growth and yield data and present it for publication in advance of the other data which the study produced. Compilation of data on the width and rings in sap wood of black walnut has been completed and initial analysis has been made of the stump sections. These indicated a significant positive correlation of width of sapwood with D.I.B. within the limits of these data, but a negative insignificant trend occurs between the number of rings and the D.I.B. of stump. The number of rings in the sapwood varies widely.

Lake States

Statistical Methods

The increased emphasis recently placed on farm forestry prompted a study of sampling techniques to determine the most convenient methods of cruising farm woodlands. From cruise data gathered for this purpose last summer, Gevorkiantz has compared the results of different arrangements of numbers of plots, and concluded that, contrary to general belief, certain systematic arrangement of plots gives results comparable with those obtained from random arrangements. Specifically, this is the case when plots are located at equal intervals, both north and south, and east and west. The comparison showed, so far, that:

1. Both random and systematic-uniform selection of plots give deviations that might reasonable be expected from the theory of errors.

2. The frequency distribution of "t" obtained from systematic-uniform sampling is as normal as that obtained from random sampling.

3. Chances of failure of either of the two methods to represent the universe, due to heterogeneity of the population, are about equal.

Pacific Northwest

Stand Studies

The 1938 remeasurements of the Station's Clatsop Country permanent growth sample plots in second-growth western hemlock add another interesting chapter to the record life history of

this type. Briegleb reports that in 90 years the stand on site quality class III had produced 90 thousand board feet per acre, Scribner rule. However, subsequent to this age the stand has suffered greatly from windfall. On one plot in this stand 26 thousand board feet per acre were blown down during the period 1933-38. This loss was not due to winds of hurricane velocity for stands of younger age weathered this period with reality low mortality. The trees were not uprooted but were broken off near the ground where heart rot had reduced the trunk to a mere shell, unable to withstand normal wind stresses. It would be inexact to attribute this loss to wind alone. The stand is beginning to break up, and as trees in the dominant canopy go down the openings thus made are quickly occupied by hemlock seedlings. Thus, at 90 to 100 years of age, a transition from even-aged to uneven-aged characteristics is under way; the period of maximum growth has perhaps already been determined by the rot that is present.

This trend is in conformity with a finding of the Station's even-aged spruce-hemlock yield study. In that study it became apparent that fully stocked, even-aged pure hemlock stands more than a century old are peculiarly lacking in Oregon and Washington, although there are thousands of acres of well-developed, fully-stocked hemlock stands of all ages up to that age. Hence, it appears that this is a desirable rotation age for such stands, owing primarily to their susceptibility to fungous infection.

Southern

Tree Studies

Form-Point Volume Tables for Second-Growth Loblolly and Shortleaf Pines. During the last four or five years a large number of volume tables have been made by the form-point method (form-point is defined as the ratio of the diameter inside bark at the top of the first 16-foot log to d.b.h., o.b.) This method was originally developed for use in virgin hardwoods, where it was observed that merchantability was not governed by a minimum usable top diameter. The assumption was made, therefore, that form-point was not correlated with merchantable length. The validity of this assumption has recently been tested for second-growth loblolly and shortleaf pines cut on the San Jacinto Experimental Forest. Form-points for 175 loblolly pines and 61 shortleaf pines were sorted by species, d.b.h., and number of 16-foot logs. The analysis of each set of data is shown in table 1. In only 2 species-log length groups was the variation due to diameter class significant, but even in these cases a plot of the average form-point over diameter revealed no trend. The important point

to note is that for each species the mean form-point (shown in table 1) varies with the number of logs, or merchantable length. The significance of this variation is shown in table 2.

Table 1.- Analysis of variance of form-point

Source of variation	Degrees of freedom	Sum of squares	Mean square	Standard deviation	F	Probability
Shortleaf - One-Log Trees - Average Form-Point: 77.4						
Between D.B.H. classes	3	16.7762	5.5921	2.3648	3.4656	Less than .05
Within D.B.H. classes	23	445.7424	19.3801	4.4023		
Total	26	462.5186				
Shortleaf - Two-Log Trees - Average Form-Point: 80.1						
Between D.B.H. classes	5	99.0425	19.8085	4.4507	1.1245	More than .05
Within D.B.H. classes	28	493.2222	17.6151	4.1970		
Total	33	592.2647				
Loblolly - One-Log Trees - Average Form-Point: 77.8						
Between D.B.H. classes	4	23.1774	5.7944	2.4071	1.4911	More than .05
Within D.B.H. classes	19	164.1559	8.6398	2.9394		
Total	23	187.3333				
Loblolly - Two-Log Trees - Average Form-Point: 79.4						
Between D.B.H. classes	11	152.3763	13.8524	3.7219	1.0569	More than .05
Within D.B.H. classes	116	1520.3034	13.1061	3.6202		
Total	127	1672.6797				
Loblolly - Three-Log Trees - Average Form-Point: 81.3						
Between D.B.H. classes	6	84.1220	14.0203	3.7444	2.8487	Less than .05
Within D.B.H. classes	16	78.7476	4.9217	2.2185		
Total	22	162.8696				

Table 2.- Significance of variation of form-point with number of logs

Comparison	Loblolly		Shortleaf	
	t	P (t)	t	P (t)
1-log trees vs. 2-log trees	2.38	.05	2.43	.05
1-log trees vs. 3-log trees	4.70	.01		
2-log trees vs. 3-log trees	3.43	.01		

All values of "t" in table 2 are significant. This test indicates that for second-growth loblolly and shortleaf pines on the San Jacinto Experimental Forest volume tables based on average form-point will give incorrect results if used to compute the volume of individual logs, which is necessary if each log is graded and the total volume in each log grade is desired. Volume tables based on different merchantable lengths in each d.b.h. class, however, should give satisfactory results if applied to stands having the same average form and distribution of merchantable lengths.

Comparisons of the curved volumes of individual logs from trees of different merchantable lengths are given in table 3. Individual log volumes based on average form-point and average merchantable length are overestimated in trees below average merchantable height, and underestimated in trees above average merchantable height.

Table 3.- Comparison of curved volumes of individual logs from trees of different merchantable lengths.

D.B.H.	First log of				Second log of		
	1-log trees	2-log trees	3-log trees	All trees	2-log trees	3-log trees	All trees
Inches	Volume in Bd. Ft. - Scribner Rule						
	LOBLOLLY PINE						
10	28	38	(42)	32	25	(26)	25
12	45	52	60	50	32	38	33
14	66	71	78	72	46	55	47
16	89	96	103	98	63	75	65
18	115	126	136	128	86	97	89
20	147	163	174	163	114	122	116
	SHORTLEAF PINE						
10	27	37		32			
12	44	52		47			
14	62	71		68			
16	(82)	95		94			

NOTE: Values in parentheses are extrapolated.

NAVAL STORES

Southern

Gum Extraction

Effect of Advance Streaks. Analysis was recently completed on an advance streak study consisting of 60 slash pines worked during 1936. An advance streak chipped 9 weeks ahead of regular chipping was found to increase gum yield over the "no-advance streak" for approximately the first 8 - 12 streaks. A streak chipped 21 weeks in advance of regular chipping exerted its influence somewhat longer than one chipped 9 weeks in advance. Each advance-streak group yielded nearly 50 percent more gum for the first and second regular streaks than the group which was not advance-streaked. At the time of the tenth streak, however, this difference had become small. Comparison of the season's yields showed approximately 5 percent greater yield from each of the advance-streaked groups.

Gum Yields

Gum Yields from A Slash Pine Plantation. During 1939 an opportunity was afforded to study the gum yield from small plantation-grown slash pines, 20 miles beyond the natural range of the species in north Georgia, in cooperation with the Georgia Division of Forestry. W. R. Mattoon, Extension Forester of the U. S. Forest Service, was responsible for the establishment of this 1-acre plantation in 1924 with wildings spaced 6- by 8-feet. A total of 142 trees was chipped with streaks 1/2-inch high and 1/2-inch deep on one-third of the breast-high circumference for the 32-streak season. Five-inch trees yielded at the rate of 10 - 18 units per crop, depending upon growth rate; 7-inch trees, 23 - 31 units; and 9-inch trees, 37 - 45 units. These yields are comparable with those from similar diameters and growth rates within the naval stores belt proper. These results gain considerable significance because of the many rumors of phenomenal yields from this and similar plantations of pines. It is the larger number of trees per acre rather than higher yields per tree that make such plantations attractive as naval store chances.

REGENERATION

California

Planting

Rodent repellent trials. Seeds of incense and Port Orford cedar are seldom eaten by rodents. This refusal might be due to seed size and lack of food material, or to some undesirable substance contained in the seed. Both seeds contain oils that impart a characteristic odor (and possibly taste) and might be repellent to rodents. Dr. Mirov made petroleum ether extracts of both seeds and an oil, steam distilled from Port Orford cedar sawdust. Neither of these substances afforded any protection from rodent attack when applied to pine seed.

Seed Studies

Color of Seed Coats Useful in Segregating Pine Seed. In grading 1938 seeds which resulted from 1937 pollinations, it was noticed that seeds from the same parent differed in seed-coat color. The seeds were first graded by running them through a fanning mill with the intention of separating the hollow from the sound. Each

resulting lot of seeds was found to include both light and dark colored seeds with varying proportions in each case. This result appeared in seed from wind and controlled pollinations of one shortleaf and two loblolly pines.

When each lot of fanned seeds was subjected to weighing and cutting tests it was found that all the seeds of one color were sound and all of the other color were hollow. This indicated that the fanning mill could not be depended upon accurately to separate hollow from sound seed. The hollow grade according to the fanning mill segregation included a small percentage of sound seed and the sound grade included some hollow seeds. Since the difference in seed-coat character was distinct, however, the impurities in each fanning-mill grade (weight class) could be removed quickly. The data for the three trees are tabulated below:

Seed tree	Color	
	Sound seed	Hollow seed
P. echinata-V 22	Dark	Light
P. taeda N 21	Light	Dark
P. taeda V 30	Dark	Light

Whether or not such differences apply to the pines generally is not known. Where they do apply, they will be of considerable value, particularly in handling seeds from controlled pollinations. Since hollow seeds should not be sown in any test, and sound seeds should not be eliminated, a precise and convenient method of separating the two classes would be a valuable aid in breeding work. Fanning-mill tests are convenient but not precise; weighing tests are precise but not convenient; X-ray photographs are precise but expensive and somewhat inconvenient; and, of course, cutting tests are out of the question with hybrid seed. Separation by seedcoat characters would combine both convenience and precision.

Nursery

To provide arboretum ground for the outplanting of progeny test trees this winter the clearing of eleven acres of Institute land has just been finished following six months of labor by CCC workers. Unlike an ordinary land clearing job, this has involved the blasting, pulling by tractor and hand digging of all stumps of trees and brush, and the hauling away and burning outside of the area of all stumps and slash. All holes were filled with a bottom layer of subsoil and an upper layer of topsoil. The effort was made to simulate surrounding undisturbed soil conditions so that the study of hereditary differences in tree strains will be as little as possible complicated by soil factors.

Intermountain

Planting

The August 1934 Elk Creek fire in the Boise Basin occurred just prior to seed fall and large quantities of ponderosa pine seed fell uninjured on the ashy surface. Naturally, many of them germinated and produced seedlings the following spring. Prior to germination in the spring of 1935, experimental plantings had been made on this area, using 2-0 nursery stock. The result was that on a variety of sites both natural and planted ponderosa pine seedlings are now found growing side by side.

Classification of the planted seedlings into three site classes gave a rough measure of site influence on growth. (Not all of the variation in growth could be ascribed to site since the matter of initial size of planted seedling was not controlled.) Table 1 shows differences in total heights of seedlings for each of three bread site classes.

Table 1.- Comparison of total heights of natural and planted seedlings, October 1938, Elk Creek burn, central Idaho

	Good site	Medium site	Poor site
	Total height Inches	Total height Inches	Total height Inches
Natural seedlings 1/	12.74	10.65	10.48
Planted seedlings 2/	14.15	9.24	5.36
Mean Difference (Natural minus planted)	- 1.41	+ 1.41	+ 5.12°

° High significant difference
1/ Seed germinated in May, 1935
2/ 2-0 nursery stock planted in early May, 1935

On the good and medium spots the planted stock had attained a size roughly equal to the natural seedlings at the end of the fourth growing season. This means, of course, that the natural seedlings actually grew much faster since they started from scratch whereas the nursery stock had tops ranging from at least 3 inches to 6 or 8 inches at planting time. On the poor sites the superiority of the natural seedlings is pronounced. This comparison is weakened by the fact that the planted stock was not from native seed source; it is not known what differences would have obtained had both sources been indigenous.

Seed Studies

Table 1 gives some pertinent information on types of seed trees selected for a study of seed collection from standing trees and a rough idea of how certain factors affect the rate of cone gathering. The values represent averages from 25 "random" trees for each type.

Table 1.- Seed tree data

Type of seed tree	Av. age-yrs	Average Height-ft.	Average No. of cones per tree	Average No. of cones per bushel	Rate of cone picking Man hrs. per bu.[o]
#1. 2nd growth stand (4,100 ft. elev.)	46	44	300	301.8	1.95
#2. 2nd growth stand (5,750 ft. elev.)	38	41	222	250.7	1.60
#3. Isolated 2nd growth trees (4,100 ft. elev.)	42	37	587	267.0	1.43
#4. Isolated 2nd growth trees (5,750 ft. elev.)	36	24	369	280.9	2.16
#5. Scattered mature or overmature residuals trees in cut-over area.	250±	88	1,407	267.9	2.76
#6. Open grown mature or overmature trees in upper fringe protection type.	250±	79	1,809	227.4	1.38
Mean			782	261.3	1.78

[o]Includes travel time between sample trees and half the travel time to and from the areas, i.e., the men followed the usual practice of returning on their own time. Travel time to and from areas was essentially constant for all groups, being about one hour per day; travel time between trees was very nearly the same in all instances excepting group 4 in which it was considerably greater owing to the extremely sparse type.

The dense stands at the lower elevation produced the smallest cones and the mature trees in the upper border protection type by far the largest. On the basis of these data, it is possible to

fix limits for cones per bushel by size classes, i.e., about 230 for large cones, 265 for medium, and 300 for small ones. Cone size is, of course, one of the more important factors affecting rate of plucking.

In addition to time records on cone collecting, data were also obtained on extraction, dewinging, and cleaning of seed. The extraction was effected by drying cones on canvas in the sun, raking, and finally running them through an improvised drum cone thresher. The dewinging was also by hand, the cleaning by means of a fanning mill. Table 2 illustrates time data for the various steps reduced to man-hours per pound of clean seed.

Table 2.

Operation	Time consumed in operation - man-hours per pound of clean seed
Cone collection	0.844
Seed extraction	0.237
Dewinging	0.145
Cleaning	0.039
Total	1.265 man-hours

If one were to assign a reasonable charge of 50 cents per man-hour, the cost per pound of clean seed in this case would be 63 cents. To this should be added costs of supervision, truck operation and depreciation, and special equipment which did not in this study, and would not ordinarily, amount to more than a few cents per pound. The costs, it would appear, are nominal despite the comparative crudity of the methods employed.

Lake States

Planting

The results of the planting-stock cold-storage tests which were initiated at Rhinelander, Wisconsin, by Stoeckeler last spring were analyzed during December and January and a preliminary report of the findings has been sent to Region 9 for the information of nurserymen.

It was found that lifted and baled jack, red, and white pine nursery stock may be kept in cold storage for 5 weeks without lowering its survival when transplanted. White spruce, which previously was suspected of being more sensitive to storage than the pines, showed a statistically significant drop in survival (from 93 to 81 percent) when kept in storage more than 4 weeks.

However, there was a general dropping off in size of the trees, especially after 4 or 5 weeks in storage, at the end of the growing season. This may be attributed very simply to the reduction in length of growing season because of prolonged storage.

In another phase of the same experiment it was noted that jack and red pine and white spruce that were lifted and stored just when the trees were breaking dormancy showed decidedly lower survival than lots lifted before and after this period.

Although these tests were carried out at 50° F., present indications are that temperatures should not rise over 40° F. for any length of time. If temperatures remain higher than 40°, mold is very likely to develop on the stock.

Seed Studies

That birds may play an important role in the distribution of plant species by increasing the germination of seed, in addition to transporting it for long distances, is suggested by tests made by Roe with seed of wild rose that was recovered from droppings of sharp-tailed grouse. This seed, collected last winter by Aldous at the North Dakota Branch Station, and seed from nearby bushes was sown directly in the germination room. After a period of 70 days at 75°-80° F. no results had been obtained, so both lots were stratified for 64 days at 41° F., with the results shown below:

Source of seed	Germinative energy		Total germination	
	Percent	Days	Percent	Days
Grouse droppings	17	18	17	70
Nearby bushes	2	9	2	70

Since the seed that had gone through the digestive tracts of the grouse shows considerably better germination than that of the control lot, it is believed that the grinding treatment given in the gizzards increased ther permeability of the bony seedcoats.

As a follow-up, the Station is now conducting a study in cooperation with Professor Swanson of the Division of Economic Zoology, University of Minnesota, to determine what effect ingestion has on germination of seeds of certain species commonly eaten by birds. Tests are now being made on Crataegus sp., Rhus glabra, R. vernix, Rosa blanda, Cornus candidissima, Vitis vulpina, and Ampelopsis vitacea. These species have been fed to ring-necked pheasants and quail. Future tests are planned to include other fruits and additional species of birds.

Rocky Mountain

Planting

A number of the older plantations on the Niobrara Division of the Nebraska National Forest were reexamined during the last two years to determine the effect of the recent drought on the survival of heretofore established plantations. The examinations covered plantations dating from 1915 to 1932. They included 32 ponderosa pine plantations, mostly of 2-1 stock raised at the Bessey Nursery from Black Hills seed, and 13 jack pine plantations, mostly of 2-1 stock raised at the Bessey Nursery from Minnesota seed.

NEBRASKA N. F., NIOBRARA DIVISION

	Survival % of 1915 to 1929 plantations			
	Ponderosa pine		Jack pine	
	Range	Average	Range	Average
First year survival	33 to 75	56	42 to 82	61
Fifth year survival	11 to 44	30	8 to 59	33
Survival of 1937-1938	11 to 44	29	4 to 20	10
Survival in 1937-1938 in % of fifth year survival	71 to 100	98	14 to 71	30

As indicated in the above table ponderosa pine is clearly superior to jack pine in withstanding drought (difference between survival in fifth year and 1937-1938). The figures underlined in the table are the present survival expressed as percentage of the fifth year survival and show that ponderosa pine plantations suffered little in recent years whereas jack pine mortality was extremely heavy (some jack pine loss due to winter killing). Because of severe droughts survival in plantations planted in 1930 and later is very low for both species.

No significant correlation can be established between first year survival counts and either the spring or the total annual precipitation during the respective years. the correlation between survival at the fifth year and the five year moving average of the yearly precipitations proved highly significant for ponderosa pine and significant for jack pine. Late planting resulted at an average a ten percent lower survival than planting early in the season. No other factors investigated have shown significant correlations.

Southern

Seed Studies

Moisture Content of Longleaf Pine Seed. During December and January considerable information was obtained concerning the equilibrium moisture content relationships of longleaf pine seed, requested in November for use in preparing specifications for seed storage chambers. Four samples were drawn from each of the eight 2-bushel sacks of longleaf pine seed stored in a farmers' cooperative cold storage plant in Mississippi. This plant is operated at temperatures slightly in excess of 40° F., and at humidities of 60 percent to 80 percent. When placed in storage January 24, 1938, the seed lots in the eight sacks had moisture content percentages of 36.0, 34.1, 21.9, 20.2, 16.6, 16.1, 10.9, and 10.8. When sampled December 7, 1938, the mean moisture content percentages of the eight sacks all fell between 13.2 and 14.4, inclusive. The variations about the means within sacks were very small. The greatest average decrease in moisture content as a result of the environment in this particular storeroom was 22.1 percent; the greatest average increase, 3.1 percent.

Seed in two different physical states (wings on and wings off), and at two moisture contents for each physical state (9 percent - 10 percent, and 20 percent - 25 percent) have been suspended in cheesecloth sacks over seven different saturated solutions calculated to give relative humidities ranging from 15 percent to 100 percent. Since the humidity in each sealed chamber depends not only upon the salt used, but also upon the temperature, six complete sets of chambers have been set up at six different average temperatures, ranging from nearly freezing to 70° or higher. Preliminary weighings indicate that at the end of 20 days the relative humidity completely overshadows the original moisture content of the seed in determining the final moisture content percentage. The lowest seed moisture content so far measured in the jars is 4.7 percent; the highest is 37.2 percent.

To study the rates at which moisture content percentages change, samples of seed in the four conditions just described have been put up in wire containers approximate 1 x 8 x 8 inches, under four different combinations of temperature and humidity. These lots are being weighed at intervals of one or two days.

Direct Seeding. Four plots were established on the Palustris Experimental Forest in December to test the effect of season of sowing on establishment of four pines and five hardwoods on two different sites. Later sowings will be made February 1 and March 15.

Washington Office

Seed Studies

Attention is called to the following abstract of "Effect of Phytohormones on Seeds Damaged by Formaldehyde and Other Disinfectants" by N. H. Grace, appearing in the Canadian Journal of Research, Volume 16, No. 8, pages 313 to 329: "Experiments with cereal seeds demonstrate that the reduction in germination and early growth resulting from formaldehyde treatment can be largely overcome by adding the phytohormones, 1-naphthylacetic acid or 3-indolylacetic acid, to the disinfecting solution. The optimum concentration of the hormone for individual varieties of cereals lies between 0.01 and 5 p.p.m. Similar effects were also obtained with hormones after copper sulphate and hot water treatments. The method appears to have practical possibilities, and may also be useful for comparing the physiological activities of different compounds."

This study with cereal seeds may offer some suggestions to the physiology of seed germination and may be worth following up with some of our tree seeds.

SILVICULTURE

Appalachian

Stand Improvement

Preliminary computations of crop trees stem analysis data collected on areas which received cleanings five years ago have shown significant results for the two species analyzed. White oak crop trees averaging 18 feet tall at the time of release have grown 82 percent faster in diameter and 28 percent faster in height than during the five-year period prior to treatment. For the same periods red spruce has grown 94 percent faster in diameter and 172 percent faster in height than did the same trees

before the cleaning operation. Examinations of competing vegetation have provided data for a forecast of the number of crop trees which will remain free at the end of the first 10 years after cleaning. This forecast shows that 75 percent of the white oak crop trees are expected to be free from harmful competition at this time, whereas only 45 percent of the red spruce crop trees will be free. Rapidly growing sprouts resulting from the original cleaning are the greatest contributing factor to the loss of dominance in red spruce crop trees. At the time of treatment these crop trees averaged only 7 feet in height, with the result that the competing sprouts are expected to overtop a large proportion of red spruce crop trees 5 feet or under in height at the time of treatment.

California

Harvest Cuttings

Economic selective lumbering has been the subject of much favorable discussion during the last ten or twelve years. Enthusiasm over operating profits sometimes prompts the thought that economic selection is a system of forest management as well as a method of lumbering. Emphasis is placed on the demonstrably high income from the first cut. Future income is deftly estimated by resorting to a system of confirmatory, or "post mortem" sampling for such items as growth, losses, and tree values. Thus, "research" leads inevitably to pleasurable proof of the original assumption. Actual self-supporting performance records for stands cut by the economic selection system are of short duration and admit only of the conclusion that actual income from growth will be far more variable than post mortem sampling might deceive one into believing.

In 1929 four sample plots were established in the sugar pine - white fir type - two in the Stanislaus and two in the Sierra National Forest. One plot in each forest was cut by the economic selection system, the other by the standard Forest Service method. Five years after cutting the plots were measured for the second time. Each plot was divided into 12 equal subplots of approximately one acre. Averages of growth or loss for the two methods of cutting were as follows:

	Stanislaus plots	Sierra plots
	Annual growth or loss, Bd. Ft., acre basis	
Forest Service cutting	+215	+592
Economic selection cutting	-758	+ 64

Are these large differences in favor of Forest Service cutting merely chance variations? The behavior of the several subplots furnishes a basis for speculation as to the answer to this question. The four groups of 12 subplots each are compared below by Snedicor's method for unmatched samples. (G. W. Snedicor "Statistical Methods" p.p. 63-69.)

Subplot	Stanislaus plots Annual growth or loss, bd. ft. FS	ES	Sierra plots Annual growth or loss, bd. ft. FS	ES
1	43	-598	204	-34
2	132	-1378	1299	180
3	180	-1818	581	-20
4	213	320	624	420
5	347	-3091	18	-145
6	255	-692	648	513
7	235	145	973	569
8	325	414	862	-1943
9	138	88	127	-123
10	125	304	100	-401
11	292	-2053	623	793
12	289	-743	1050	956
Totals	2574	-9102	7109	765

Method of cutting	Degrees of freedom	Means	Sum of squares (corrected)	Method of cutting	Degrees of freedom	Means	Sum of squares (corrected)
FS	11	214.5	94,657	FS	11	592.4	1,871,199
ES	11	-758.5	13,852.729	ES	11	63.7	6,263,506
	Sum=22	Diff.=973.0	Sum=13,947,386		Sum=22	Diff=528.7	Sum=8,134,705

Pooled variance, $V = \frac{13,947,386}{22}$ $V = \frac{8,134,705}{22} = 369,759,32$

$= 633,972.09$

S.E. diff.$= \frac{2V}{n} = \frac{1,267,944.18}{12} = 325.1$ S.E. diff.$= \frac{739,518.64}{12} = 248.2$

$t = \frac{M.diff.}{S.E.diff.} = \frac{973.0}{325.1} = 2.99$[1]/ $t = \frac{528.7}{248.2} = 2.13$[2]/

1/ Highly significant (P.P.01): t = 2.82 2/Significant(P.0.05): t=2.07

Perhaps the method of comparison is open to questions, the time interval is short, and the sample is small. Results for a ten year period will be available at the end of this year.

Central States

Stand Improvement

From data that have been analyzed to date it is apparent that mortality of reproduction was increased by release. Seedlings and planted pine were affected most. All surviving released reproduction, however, have shown a substantial increase in growth.

Silvics

Analyses are not complete but superiority of sassafras over black locust in soil building as measured by organiz matter accumulation is quite clear. The criteria of soil improvement are litter production, organic matter incorporation, and rate of water absorption.

Lake States

Harvest Cuttings

A logging operation recently completed on the Upper Peninsula Experimental Forest furnished an excellent illustration of how defect may be eliminated in old-growth hardwoods. The stand as a whole runs about 33 percent defective. In other words, under clear-cutting for saw logs, veneer, woodenware logs, and bowling pin stock, the stand is about one-third cull. However, the trees most desirable to remove from a silvicultural standpoint when a light selective cut is applied are a great deal more defective--in this case 78 percent. If only high-grade logs could be sold, a poor job of utilization would result. But the excellent market for chemical wood remedies what would otherwise be poor utilization. The 78 percent cull was all worked up into chemical wood with very pleasing silvicultural results. The sale of chemical wood is certainly the key to good management on this tract.

Stand Improvement

The five-year examination of improvement cuttings in young northern hardwoods at the Upper Peninsula Branch, the records of which are now being analyzed, cast doubt on the efficacy of the "crop-tree" method. Admittedly, the selection of future crop trees and concentrating the effort on them, letting the rest of the stand take care of itself, reduces the cost of stand-improvement work.

The "crop-tree" device has been widely used and generally accepted in the stand-improvement practices of the CCC during the past five years. It seems to be well adapted to conifers. However, when applied to hardwoods, it may not work out so well. At least that is the conclusion drawn from release-cutting and thinning experiments in 15-year-old maple which was overtopped by aspen of the

same age. Five years after treatment, in spite of the benefits of release, a large number of selected "crop trees" were smaller and less vigorous than their neighbors, and there is very indication that another five years will bring about still further changes. It seems doubtful from this evidence whether "crop trees" of northern hardwoods can be selected with any assurance until the stand is much older than 15 years, and perhaps not until it is 30 or 40 years of age.

Northeastern

Silvics

Soil Fauna. After much seeking, a specialist on the Euchytraeid earthworms was located and induced to determine the one and only species found in spruce humus. This species was found to belong to the genus Buchholzia, never before recorded from the United States.

Although there are forty to sixty of these worms per square foot, they are so minute as to be of no significance in themselves in reducing the litter.

Northern Rocky Mountain

Stand Improvement

Data from the fifth-year examination of nine ponderosa pine thinning plots established during the summer of 1933 in 45-50 year old stands near Frenchtown, Montana, show that treatment has had a measurable effect even in this short time. The plots consist of two groups, each located in a separate stand. In the one group are three plots of different weights of thinning from below and one unthinned check plot; in the other group are four thinned plots representing two weights of thinning from below and one check plot. Both check plots were marked for thinning by the various weights of thinning in order that comparisons of growth between thinned and check plots could be made on comparable trees.

The low mortality on the thinned plots, as contrasted with the large number of trees which have died on the unthinned plots, indicates that thinning removed most of the trees which would ordinarily have died.

Diameter growth comparisons are probably the best criteria at the present time of treatment effects. Although the data contain minor inconsistencies, they show that thinning has stimulated

diameter growth and that diameter increase has been favored more by heavy thinnings than by light. Statistical analysis has shown these differences to be real.

Growth in height was examined in a like manner but no significant differences were found.

Basal-area growth, as would be expected, shows the same trend as that shown by diameter growth.

Aside from the measurable effects of thinning, increased stand vigor, as evidenced by the appearance of individual trees, was apparent. In the heavily thinned stands the crowns were larger, thicker, and of a healthier green color. Comparisons with similar trees on the check plots showed that all of these differences could by no means be ascribed to the fact that only the better trees were left on the thinned plots. On the heavily thinned plots it appeared that trees might become "wolfish" before the stand could close sufficiently to shade out lower branches. However, it will be a number of years before such a tendency can become marked. At present, apparent and measurable effects of thinning are favorable. It is doubtful, however, if thinnings in such stands are justified under present economic conditions in the region.

Pacific Northwest

Stand Improvement

Based on a critical examination made last fall of areas on east side national forests that have been given stand improvement treatments, a manuscript, "Stand Improvement Technique and Organization for Ponderosa Pine Forests" has been completed by Kachin and Welch. This work is to be included in the Regional CCC Handbook for the use of technical foremen.

A four-acre spot thinning demonstration plot was established in ponderosa pine reproduction on the Whitman National Forest in order to illustrate concretely for CCC foremen, enrollees, and others desirable crop tree selection and release. The plot is designed as a randomized block and will be valuable for research as well as for demonstration purposes.

Southern

Stand Improvement

Thinnings in Old-Field Loblolly Pine. Data from nine thinning plots in old-field loblolly pine at Urania, remeasured in November, were summarized in December and January. Established in the fall of

1928, these plots are now 31 to 42 years old. Four plots were thinned from above in both 1928 and 1933, one was thinned (from above) only in 1928, and four are check plots. The net volume growth during the last 5-year period has averaged 0.8 to 2.1 cords per acre per year, with very little difference between the thinned and the corresponding check plots in this respect. During the same period, total mortality on the check plots have averaged only 0.1 to 0.4 cord per acre per year. The average diameters of the check plots have increased 0.6 to 0.9 inch during the last 5 years, and the corresponding increases on the thinned plots have been 0.6 to 1.3 inches.

Harvest Cuttings

Individual-Tree Study of Growth and Mortality. The loblolly tree study established last June on the San Jacinto Experimental Forest was expanded in December and January to obtain a representative sample of both shortleaf and loblolly pines in the 4- to 8-inch d.b.h. classes. A few larger shortleaf pines were also included. The object of the study as a whole is to determine the growth and mortality of individual trees in partially cut stands as related to the size, character, and position of the trees. The study was expanded in order to obtain a much better sample of the smaller trees, and to include shortleaf as well as loblolly pine. These smaller trees have usually been severely suppressed, and have little or no present stumpage value. There is considerable difference of opinion as to what the future holds for such trees. Some believe that these trees, as a group, will not make enough net growth to justify their retention in the stand (since mortality is likely to be high), and that consequently they should be salvaged at the first opportunity. The marking rules for the Texas National Forests, however, have forbidden the cutting of trees less than 8 inches d.b.h. This rule is based on the assumption that if such trees die there is virtually no loss of stumpage value, whereas if even a few such trees continue to live and grow they will eventually acquire a good stumpage value, enhanced by higher-than-average clear length. A total of 194 trees, ranging from 4 to 12 inches in d.b.h. and including four degrees of release from competition, were tagged, measured, and described.

Southwestern

Silvics

Stages of growth of pinons in 1938. Field data on stages of growth of pinons (Pinus edulis) and their relation to weather conditions were obtained in 1938 at the Walnut Canyon pinon plot on the Coconino National Forest about 12 miles east of Flagstaff,

Arizona. A climatic station was maintained here from April to October, and at weekly intervals notes and measurements of buds, shoots, needles, cones, and nuts were taken. Specimens for later microscopic examination were preserved at intervals from one to a few days.

The last killing frost occurred May 8. Vegetative buds began growth after the middle of May. Elongation of most shoots had ceased by the end of June, when the needles, which were formed in winter buds late in the summer of 1937, became visible beyond their sheaths. Some of the more vigorous shoots made a small amount of additional growth with new needles in July. All needles continued to elongate until the last of August. Winter buds were formed in August and September, and the first killing frost came October 8, after a frostless season of 153 days.

Buds in which microscopic stages of staminate cones were formed the preceding August and September started to grow about the first of May. The small yellow staminate cones became visible the first of June and were mature by the middle of the month. Shedding of pollen and pollination of the 1939 ovulate cones took place mostly from June 15 to 18, a period of warm, dry, windy weather. Then the staminate cones died and were shed.

The 1939 ovulate cones, or those which mature in 1939, were formed microscopically in winter buds during August and September 1937. These cones emerged and were pollinated in June 1938 and continued to grow until the end of August, when they became the familiar, year-old immature cones about 1/2 inch long.

The 1938 ovulate cones and nuts, those maturing in 1938, resumed growth the first of May 1938. Fertilization occurred about the first of July, about 12-1/2 months after pollination. By the middle of July the seeds, or pinon nuts, although not mature internally, were full size and their seed coats, or shells, were starting to harden and to become dark in color. The nuts were mature by the first of September and started to fall as the cones opened the last of the month. Most of the nuts of this very light and not commercail crop fell to the ground in the first part of October.

Tamarisk. Finished samples of tamarisk wood attracted the immediate interest of furniture manufacturers when shown in Grand Rapids last summer. Very light-colored woods are much in demand to supply the present trend toward wood furniture of light color. Tamarisk wood is not only almost white, but is hard and dense, and displays beautiful medullary rays. In order that the suitability of tamarisk wood for furniture manufacture may be definitely determined, the Southwestern Station, in cooperation with the University of Arizona, shipped nine tamarisk logs to a furniture company in Grand Rapids and five to the Forest Products Laboratory for testing purposes.

Tamarisk, or salt cedar (Tamarix articulata), is an exotic introduced to the Southwest from western Asia about 1902. It grows very rapidly on irrigated desert land and propagates readily from cuttings. In recent years it has been widely planted throughout southern Arizona for windbreaks and shade. Although the available supply of merchantable material is not large, growth is so rapid that a substantial amount could probably be grown in a relatively short time. The tamarisk trees in the windbreak near Yuma from which several test logs were cut reached an average height of 60 feet with diameters between 20 and 30 inches, 16 years after planting. The results of the tests under way may prove of great importance to both furniture manufacturers and farmers of southern Arizona.

Washington Office

An improved field paint sprayer developed by, and now standard equipment for, the Maps and Surveys division of the T.V.A. for painting contour lines on trees is described by G. D. Whitmore on page 30 of the Engineering News-Record for January 5, 1939.

In this sprayer the necessary pressure is generated by the evaporation of dry ice, 6 to 10 pounds of ice being sufficient for an average day's work at 10 to 25 pounds pressure. The unit is relatively light in weight, weighing from 20 to 25 pounds when loaded with a day's supply of dry ice and so can be easily transported. It is constructed from standard, commercial equipment at a cost of less than $20.

Aluminum paint with a special mixing oil gives best results with the gun and is most satisfactory for brightness and lasting qualities. Outside white lead also works well when thinned with 1/2 gallon of linseed oil with each gallon of paint.

Since spray painting uses less paint than brush painting and has other desirable features it may be worth investigating this apparatus further.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Production - Christmas trees. Production of Christmas trees in western Montana in 1938 was up to expectations, with 1,676,000 trees being produced. Of this number eight percent were supplied by national forests, one percent by State forests, and 91 percent by private lands. Anderson and Rapraeger recently prepared a report on the Christmas tree industry, which was distributed locally.

Census. The annual canvass of lumber producers is under way in cooperation with the Bureau of the Census.

TIMBER HARVESTING AND CONVERSION

California

The selection of Brundage for transfer to the New England Timber Salvage Administration will seriously hamper immediate progress in Products at this Station. There will be an emergency revision of Division plans for the rest of this fiscal year. What can be undertaken after that cannot be planned until something is known as to his replacement here.

Pacific Northwest

Conversion

A large proportion of the available time of the Products staff has been given over to preliminary and exploratory calculations for a report combining the data for the six mill-production studies conducted in this region since 1935. A consolidation of all ponderosa pine sawing time studies in order to establish time curves for log lengths other than 16 feet was begun. Necessary tabulations of all studies by lengths, diameters and degrees of defect were completed. Tabulations for sound logs were summarized and ratios of average sawing times of other lengths to the 16-foot sawing time curves were computed. Individual ratios of 16-foot defective log to 16-foot sound logs sawing times were completed. The study of shipping tally ponderosa pine lumber grade recoveries by log grades

under various types of mill practice carried on in the Oregon pine region was continued. Mill practices are divided into four types according to the proportion of box lumber produced. These proportions are 0, 10, 30, and 60 percent of the total production. Log grade 1 has been completed for all of these practices. The remaining log grades have been completed only under the 60 percent type.

The report on the Flagstaff, Arizona, study was completed and sent to the Southwestern Station. The data from this were reworked using costs and sales returns of the New Mexico Lumber and Timber Company at Bernalillo, New Mexico, and a report of the results sent to the Southwestern Station.

The study made at Lakeview, Oregon, in June 1937 is ready in rough draft, and awaits only a check on the costs. Part II of a report on the Shevlin-Hixon study of 1937 has been completed in rough draft, and awaits only a check on the costs. Part I of this report, prepared in August, 1938, presented the results and conclusions of the study; Part II describes the mill and office procedures used.

WOOD PRESERVATION

Northern Rocky Mountain

That treated western hemlock is highly satisfactory for railroad ties is shown by the results of the 1938 examination of the test track which was established in February 1910 in cooperation with the Northern Pacific Railway Company. Only 38.8 percent of the hemlock ties have been replaced after almost 29 years of service, and indications are that the average life of these ties will be close to 33 years. At present, renewals of hemlock ties amount to only 7 percent annually.

In considering the life of these ties, it should be understood that though the test track is on the main line it is not a high-speed track because of its proximity to the Missoula yard. Nor does the track contain steep grades and sharp curves. Officials of the Northern Pacific believe that the average life figures resulting from this test will be somewhat higher than can be obtained throughout the Rocky Mountain division.

At the 1938 inspection, renewals of Engelmann spruce amounted to 72.2 percent, and indications are that the average life to be shown by final figures will be approximately 22 years. The life expectancy of western larch and mountain Douglas fir ties in the test track is similar to that of western hemlock.

All ties in the test track were treated by the Lowry process, the impregnation consisting of 6-3/4 pounds per cubic foot of No. 1 creosote (80 percent) and refined coal-tar (20 percent). The original installation contained 1,072 Inland Empire hemlock ties, 436 western larch, 166 mountain Douglas fir, 102 true fir, 18 Engelmann spruce, and 6 ties of other species.

FOREST AND RANGE INFLUENCES

FLOOD CONTROL SURVEYS

Appalachian

New River Drainage. H. J. Loughead, member of the Field Working Committee, spent a large portion of January developing a new method for obtaining data for flood surveys on the New River drainage in West Virginia. Loughead was accompanied by representatives from the Soil Conservation Service and from the Bureau of Agricultural Economics.

The plan for this field work was arranged cooperatively with the State Agricultural Extension Service and was carried out largely through direct contact with the county agents.

California

Preliminary Examinations

During December and January, Preliminary Examination Reports covering 6000 square miles in the watersheds of Kern and Pajaro Rivers were completed and sent to Washington. Reports on an additional 7700 square miles in the Kaweah, Tule, Santa Maria and Salinas watersheds are now in Committee, while completion of the report for the Sacramento River above Shasta Dam is scheduled for the middle of March. The latter area covers about 6500 square miles.

Flood control hearings on the San Lorenzo and Santa Ynez Rivers were held in December, at Santa Cruz and Lompoc respectively, and on the Napa River at Napa in late January. The Napa hearing was notable for the fact that the local people placed greater stress on the need for increased protection of the forest cover against fire, and for the control of soil erosion on foothill orchard and crop lands, than they did on dams and levees to remedy their flood and water problems.

The Santa Ynez study will be of unusual interest because this drainage embraces the sources of domestic water for the cities of Santa Barbara and Montecito and lies entirely within Los Padres National Forest. In the 12 years from 1922 to 1933 inclusive, 72 percent of the watershed has been denuded by fire. By 1937, erosion deposits in Santa Barbara's Gibraltar reservoir had displaced approximately 30 percent of the reservoir storage capacity. Montecito's Juncal reservoir, several miles above Gibraltar, has also received considerable deposition of eroded material which has not yet been surveyed.

In 1936, in an effort to prevent further deposition in Gibraltar reservoir, the Forest Service in cooperation with Santa Barbara City authorities, constructed two dams in the Mono and Caliente tributaries. The Mono basin, capacity 600 acre-feet, has been completely filled with sediment in two years, and the Caliente basin, constructed one year after the Mono, has lost about one-third of its capacity by sedimentation. Leading citizens of both Santa Barbara and Montecito are well aware of the seriousness of the situation and have made several tours of the watershed with Forest Service officials to study and discuss the problems of fire control and watershed improvement.

Emergency Flood Control Action. During January funds were received by the Regional Office for emergency flood control work on the recently burned watersheds of the San Bernardino and Angeles National Forests. The Flood Control Survey crew cooperated with administrative officers in a rapid reconnaissance of the burned areas and the development of a program of emergency measures of control. The proposed measures include: Sowing of the burned areas with mustard seed; clearing of dead trees and other obstructions from specified reaches of the stream channels; construction of debris "sumps" at carefully selected sites in canyon bottoms to catch and hold large boulders; construction of a limited number of masonry channel barriers; road slope fixation and drainage improvement; and a limited amount of landslide stabilization.

Central States

Preliminary Examinations

Practically no work was accomplished during December on preliminary examinations because available personnel was used on detailed surveys. On January 5, Marshall was assigned the preliminary report on Wolf and Nonconnah Rivers, Tennessee and Mississippi, and Yellow Creek, Kentucky and Tennessee (a tributary of the Cumberland River).

Watershed Surveys

Since the last report, material progress has been made in mapping the major soil divisions on the St. Francis Survey. Progress in making contacts and surveys of the individual farms also was made. Clearance on purchases of ten recording rain gages for measuring precipitation was obtained, as were cooperative plans with the U.S.G.S. in establishing additional gaging stations on tributaries and points in the headwaters portions of the river. Foster, working by boat, completed the field measurement of many cross-sections on a portion of the river as part of the detailed study of the channel in relation to its hydrology. Progress was made in the survey of regeneration and its rate of establishment.

It has been decided tentatively by the Field Working Committee of the Muskingum Survey to withhold the completion of the report on Atwood and Leesville Watersheds until further progress has been made on the survey of the Muskingum Watershed as a whole. Studies are now being made on the Killbuck Watershed. Flood damage figures for this area have been compiled. It is planned to proceed immediately with a reconnaissance of flood damages on the other tributaries in the Muskingum Watershed to determine priority and need of survey.

Artificial Rain-Maker and Run-off. The artificial rain-maker was completed and preliminary tests on the St. Francis Watershed were made on five plots before freezing weather. Sufficient knowledge is now known concerning the rain-maker and its limitations to draw up a sound working plan for the tests to be conducted next spring. Marshall has been assigned to write a progress report on the rain-maker to date, and to draw up a working plan for additional tests.

Intermountain

Watershed Surveys

Interim Report Completed: An interim report containing a preliminary survey report on the entire Boise River watershed and a detailed report and work plan for the Willow Creek Work Unit was completed and forwarded to the Washington Flood Control Coordinating

Committee early in December. Major controllable causes of the flood damage were found to be accelerated erosion on depleted range, on burned and cut-over forest, and on placered upstream valley bottom areas, and reduction in the capacity of the main river channel and of irrigation storage, diversion, and distributing works in lower Boise Valley.

The Willow Creek Work Unit, a 77,000-acre area adjacent to the Arrowrock Reservoir, was selected for detailed study because a preliminary inspection of the entire watershed revealed this unit to be one of the most serious contributors of silt and because earlier surveys and research indicated that control could be affected by a relatively simple program of improvement measures. The control work recommended for this unit includes contour furrowing, artificial reseeding, shrub planting, restriction of grazing, and low debris dams to stabilize moving sand and gravel bars. A spot survey which sampled about 15 percent of the unit was used to determine the amount of each kind of control work that is required on the area.

Cooperative Siltation Study Initiated by U. S. Geological Survey: A siltation study to determine the relative contribution of destructive sediment from tributaries characterized by different soil and plant cover conditions was initiated by the U. S. Geological Survey in January through a cooperative arrangement worked out by the Flood Control Coordinating Committee. Suspended silt samples are to be taken at 13 stations so located as to indicate the relative contribution of sediment from forest lands characterized by virgin, cut-over, grazed, burned, and placered cover conditions and from moderately and heavily grazed range areas. Temporary metal flumes of the "Modified Venturi-Trapezoidal" type developed for the Farmington Canyon experimental watersheds in Utah are being used in several of the new gaging stations which had to be established for this study. An integrating sampler will be used for taking the silt samples. It is planned tentatively to conduct the study for at least one year. The data will be used as a guide for evaulating the amount of effort that may be justified in applying erosion control measures on different types of problem areas within the watershed.

Water Users to Install New Sand Trap: The Boise Project Board of Control, a water users organization having jurisdiction over the irrigation system for about one-half of the 340,000 acres of irrigated lands in Boise Valley, recently voted to install a newly designed riffle deflector-vortex tube sand trap on their largest (40-foot) irrigation canal. The new type sand trap was designed by Mr. Ralph Parshall of the Bureau of Agricultural Engineering at Fort Collins, Colorado.

Laboratory model tests revealed this type of trap to be 97 percent efficient in removing the bedload of coarse sand and gravel which to date has been a major source of damage in the irrigation system. The trap will be installed after the 1939 irrigation season. It is estimated this installation will cost only about one-half of the amount being expended annually to clean the canal by drag line.

Mr. Parshall, in cooperation with the Boise Survey Project, is also designing a mechanical sampler device which will be attached to the sand trap for measuring the amount of bedload that is washed from the canal.

Erosion Reduces Infiltration: The erosion condition and organic matter content of the surface soil was found to have a significant bearing on the infiltration rate of soil on the range portion of the Boise River watershed, according to partially analyzed results of a special study made last fall by the Flood Control survey crew. Using portable absorption apparatus on a total of 72 one-foot square plots, the infiltration rate of moderately and seriously eroded areas was found to be 88 and 62 percent, respectively, as fast as uneroded areas. Areas of low organic matter content absorbed water 73 percent as far as areas having high organic matter content. The study provided for the isolation of the factors of soil texture (coarse and fine) and soil origin (granitic and rhyolitic) but variance analysis of the data proved these factors to be of no significance except in certain interactions.

The results of this study are to be correlated with those from the U. S. Geological Survey siltation study and other data in determining the benefits to be obtained from the application of watershed improvement measures.

Lake States

Watershed Surveys

Field work on the detailed survey of the Kickapoo watershed has been supplanted by office work during the winter months. Compilation of the data collected from the intensive examinations made on the sample farms has been started. Each of the three bureaus is analyzing some portion of the data. Preliminary results indicate that the damage figures presented in the preliminary reports of both the Army and the Department of Agriculture were too high. These estimates of damage were based principally on figures submitted by the Kickapoo Valley Flood Protection Association. The Association's figures were scaled down somewhat before inclusion in the report but apparently the real damage is still considerably lower.

Preliminary Examinations

Work on the preliminary examination report of the Black River is nearing completion. A peculiar situation with regard to run-off from the upper end of the stream made necessary a quite detailed investigation of the hydrologic record of this stream. Observation of the area itself does not readily disclose the fact, which is revealed by the discharge records, that the upper end of the watershed above Neillsville yields a large portion of its water in the form of surface run-off.

Northeastern

One of the interesting and difficult problems which comes up in the survey of the headwaters of the watershed to determine methods of controlling flood run-off is the matter of clearly showing the way in which flood waters gradually accumulate to produce a major flood. By carefully studying the hydrographs and flood profiles, it is possible for the technicians on a flood control survey to obtain a fairly clear idea of just how the flood waters accumulate.

In our search to find a clear, graphical manner of presenting these facts so that a person could quickly see the way in which flood waters accumulate, the best method we have found at this time is described by Professor J. W. Goldthwait in an article entitled "The Gathering of Floods in the Connecticut River System" which appeared in the Geographical Review for July 1929. Using this method, the accumulated flood waters are shown on a series of maps, each indicating the location of the flood crests at a specific hour during the flood period. Four of these maps for each day during the flood period would show the position of the flood crests on all the tributaries at the end of each six-hour period. The position of flood crests is shown by drawing a very heavy line from the headwaters of each tributary down to the point which the flood crest had reached at the hour indicated on the map.

Using such a series of maps it is very easy to follow the flood crests down each of the tributaries and down the main stream, and see the way in which high water from the several parts of the watershed accumulates to produce the main stream flood. The shortcoming of the method is that it cannot show for each stream the duration of the high water which can be seen by studying the shape of the top of the hydrograph, and which is important in an analysis of the flood contribution of various tributaries. For this reason some thought is still being given to other possibilities of presenting this flood runoff picture graphically.

Pacific Northwest

The preliminary examination report for the Nooksack River has been approved by the Bureau of Agricultural Economics and the Forest Service Committee members and early approval by the Soil Conservation Service member is expected. The report for the Tanana River watershed in Alaska was submitted to the other bureaus in December for comments. These have been received and the report as revised, sent to Mr. Merritt of the Regional Office for review.

A book of the Geological Survey River Plan and Profile sheets, covering the streams in Field Committee 22 for which these sheets are available, has been made up. It should prove useful in locating areas subject to overflow and in examining proposed dam sites for water storage.

A study was made of the precipitation and snow conditions before and during flood periods to determine the effect of snow melt upon runoff during major floods. The records for the nine meterological stations in western Washington over 1,200 feet in elevation were analyzed. The data are meager, but several interesting tendencies were noted.

1. Snow storage below about 2,000 feet is generally light and the run-off from it is gone prior to the development of serious flood conditions, hence below this elevation melting snows contribute little or nothing to the flood peak.

2. At elevations over about 2,000 feet run-off from melting snows is a source of flood water to a varying degree, depending upon elevation, exposure, and climatic conditions.

3. Comparison of the estimated water content of the snow melted during a 72-hour period prior to the flood peak with the rainfall for a like period indicates that the run-off from melting snow is but a small part, generally less than 20 percent of that from rain.

Rocky Mountain

Preliminary Examination

C. H. Diebold, who has been making preliminary examination for the experiment station, has accepted a transfer to the Allegheny Forest Experiment Station, at Philadelphia. In his new job Diebold will be in charge of Forest Service work in the detailed survey of the Youghioghony drainage.

Taking his place at this station is Leland K. Hill, transferred here on January 1 from the Appalachian Forest Experiment Station, where he had been in hydrologic and flood survey work since 1937. Hill will be in charge of preliminary examinations and surveys for the Forest Service as a member of the Field Working Committee.

Watershed Surveys

A special report on floods in Bear Creek watershed near Denver has been completed. The Fountain Creek and Washita surveys are each about sixty percent finished and some of the field men on the Fountain Creek survey will soon be detailed to start work on the Cherry Creek survey.

Southwestern

Watershed Surveys

The Queen Creek flood-control survey has received most of the attention of two members of the Southwestern staff during the last 4 months. The field survey of this watershed, which comprises about 880 square miles in south-central Arizona, was made, for the most part, during August and September. Analyses of the data collected by various members of the three Services — B.A.E., S.C.S., and F.S. — were begun the latter part of September at Albuquerque, the headquarters of the watershed Chairman. The correlation and interpretation of the factual data, together with maps, are practically finished, thus completing this part of the report. Parts of "Plan of improvement" are in preparation, and the material is being set up in final form as soon as received. Based on total man hours, including collection of data, the Queen Creek survey job is practically 95 percent covered, and the report about 85 percent completed.

Preliminary Examinations

Rio Puerco, in northwestern New Mexico, above its confluence with Chico Creek, has been authorized for survey. In order to facilitate matters, a brief report on the conditions of the Rio Puerco watershed as a whole is planned, together with a flood-control survey of one of its flood-source areas. One southwestern staffman joined an interbureau party in a quick examination of the whole watershed. A brief watershed-condition report is about half completed. Chinilla Arroyo drainage area, immediately west of Cuba, New Mexico, has been selected for survey as soon as weather conditions will allow.

Gila River survey of the upper Gila, or the part of the drainage above the San Carlos irrigation project in Arizona, was begun October 1, 1938. This large area consists of the headwaters in the Gila and Crook national forests and lower mountains and valleys draining into the upper Gila Valley. In order to facilitate work and make survey findings available from time to time on a long-time project, this part of the Gila watershed was divided into unit drainages of the whole. Field work on the first of these units, the Gila proper above Cliff, New Mexico, was completed in January 1939. The resulting data are now being organized into report form.

South Canadian River: With data available, a preliminary examination flood-control report on South Canadian watershed above Conchas Dam is being prepared in first rough draft, setting forth the conditions of this watershed.

Little Colorado: Flood-control preliminary examination report of Little Colorado River, Arizona, is nearing completion, based on data collected by S.C.S. in a general watershed fact-finding survey made in 1938.

Williams-Big Sandy: The field examination of the Williams-Big Sandy Watersheds was completed last summer. The preliminary examination report has been started.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

California

Chaparral

San Dimas Experimental Forest. During the first part of December most of the activity on the San Dimas Forest was concentrated in the Fern area which was burned over in November. The job here was one of replacing instruments destroyed by fire and preparing installations for anticipated debris-flows before the first storm of the season.

At the Fern SRE Plots the joints of all sheet-metal tanks and housings had to be re-soldered, the number of run-off catchment tanks increased to hold the expected increased run-off and the debris troughs enlarged to catch the anticipated large amount of eroded material. At the stream-gaging stations at the mouths of the Fern Small Watersheds, masonry controls were built to provide a means of estimating flood flows that might overtop the 3-foot flumes, and to protect the instrument houses from destruction by

inevitable mud-rock torrents.

The three reservoirs were emptied of the last remnants of erosion debris brought down by the storms of last March. The burned shelter house which served the observers at the triplicate dams was replaced by a portable building on the old foundation. At the Fern Plots a small shelter house was constructed for observers. Owing to the remoteness of the Fern area from headquarters and its high altitude, these shelters are indispensable during storm periods.

By cooperation with the Regional Office special equipment was hauled to the area to empty the Fern supplementary reservoir which had been completely filled during the March storm. Plans were also drawn for raising the supplementary dam by three feet, thus increasing its reservoir capacity by nearly 50 percent.

In addition to the mechanical jobs of revamping the various measuring devices, there was also developed a plan for experimental treatment of the burned area to reduce run-off and erosion rates. These included broadcast sowing of mustard, contour sowing of cereal grains, cutting and piling of fire-killed vegetation in contour windrows, some "gradoni" terracing, and the construction of check dams in Fern Canyon No. 1. Our hope of completing this program of experimental control works within a thirty-day period under highpressure proved vain, and some features of it were still untouched by the end of January.

The first rain of any consequence began on December 14, when two storms, one following close on the other, produced from 5.89 to 12.81 inches of rain over the Experimental Forest with the highest amounts in the Fern area.

In the first storm, after only one-half inch of rain had fallen, a moderate increase in intensity yielded flash flows in the three Fern Small Watersheds and the Fern Run-off Plots, and caused a deposit of mud and boulders in Fern No. 3 reservoir. Reservoirs No. 1 and No. 2 did not overflow; and the deposit in No. 1 was mostly sand and in No. 2 organic matter. After a total fall of 2.23 inches of rain in the burned area, it was observed that ash-covered soil was wetted down to a depth of only one-quarter inch, whereas mineral soil not covered by ash was wetted to a depth of three to four inches.

The second storm, which followed the first within 48 hours, produced about 8 inches of rain but with the same moderate intensities as the preceding one. A succession of flash flows was again observed in the Fern burned area, while over the rest of the Experimental Forest the run-off was very small. During this storm, Fern Reservoir No. 1 was filled to overflowing with sand,

silt and other fine material. Fern No. 2 was not quite filled. At Fern No. 3 a mud-and-boulder flow completely filled the reservoir and an unknown amount went over the dam. Meantime, from slightly less rainfall at lower elevations, no debris whatever was deposited in the reservoirs of the four Bell Small Watersheds which were untouched by the burn.

During this second storm a marked effect of the burn was observed in the stream behavior at gaging station IV, Watershed IV above that station, with an area 5.74 square miles, contains all the area which was burned inside the Experimental Forest. Prior to this season, streamflow at this gaging station was considerably less flashy and carried much less bed-load than that from adjacent Watershed V, area 4.75 square miles. This season, however, the streamflow shows a reverse condition. At one time during the second storm, a wave of debris-laden water passed through gaging station IV at a depth of 2 feet in the 15-foot Parshall flume, completely overtopped the tandem 4-foot San Dimas flume, and attained a volume rate of about 175 cubic feet per second. At the same time the flow at station V was about 50 cubic feet per second, the water was clear and was easily measured by the 4-foot San Dimas flume. Measurements at station II, upstream from station IV, showed that the wave of debris-laden water came from Fern Canyon.

The Fern Run-off Plots yielded a very good record of run-off which far surpassed in magnitude any that had been observed in the years previous to the burn while the vegetation was intact. Approximately two tons dry weight of eroded matter were removed from the baffle troughs and silt traps after the storm. In the same storm very slight run-off and no erosion whatever occurred at the Tanbark Plots in chaparral untouched by fire for 19 years.

During January three minor storms brought approximately $4\frac{1}{2}$ inches of rain, but produced a comparatively small amount of run-off. Half of this amount fell in the form of snow about 4000 feet elevation.

The San Dimas lysimeters yielded a considerable amount of run-off and produced seepage in varying quantities from all but four units. A disturbing feature which showed up during the larger December storm was the accumulation of several inches of mud in the seepage chamber in the bottom of four of the large lysimeters. This plugged the seepage outlet pipes, causing the water to back up and leak out at the inspection plates.

As a means of measuring erosion in the burned area, 100 erosion pins were set in five separate localities in the Fern Small Watersheds. These pins were distributed to sample variations in aspect, geology and vegetative types. Arranged on contours, the pins were driven 6.6 feet apart, and profile measurements were made

between pins. Soil samples were taken about 10 feet above each pin. Comparison of these soil samples with others to be taken after erosion has occurred will give an indication of the amount of sheet erosion which has taken place.

Berkeley Installations. At the Oxford Street lysimeter installation a total precipitation of 33 inches was recorded during the past season. Continued study of the influence of different depths of Monterey pine litter on the disposition of the total seasonal rainfall substantiated results of previous years, namely, a very thin litter cover decreased the run-off, erosion, and evaporation, and increased the percolation, as compared with bare soil. Specific results from the various lysimeters are presented in the following table:

Influence of pine litter on disposition of rainfall

Oxford Street lysimeters, Berkeley1/

Surface condition	Rainfall	Runoff	Percolation	Evaporation
Bare soil	33 in.	32	36	32
Litter depth, 1/8 in.	33 in.	10	70	20
Litter depth $\frac{1}{2}$ - 2 in.2/	33 in.	2.5	85	12.5

1/ Lysimeters are 7 ft. 2 in. long, 2 ft. 10 in. wide by 36 in. deep.
2/ All litter depths above one-half inch yield approximately the same results.

At the Strawberry Canyon chaparral lysimeters the annual precipitation was 38 inches. This installation includes 10 lysimeteres, of which one group of five is planted to Ceanothus cuneatus, a typical chaparral shrub, and the other group to Quercus dumosa, scrub oak, which is of widespread occurrence in California.

The Ceanothus lysimeters showed an evaporation-transpiration loss of nearly 54 percent of the annual precipitation. This was only slightly greater than the similar losses during several preceding years, indicating that the shrub association had reached its limit of growth in the tanks, and was annually using all the available moisture from each tank. Signs of distress from competition were evident among the plants during last year. Thinning were therefore made late in the summer of 1938 in time to begin the 1938-39 rain season with the new condition. The thinnings comprised complete denudation of one tank, reduction of cover

density in the second, third and fourth tanks by 75, 50 and 25 percent respectively, and no disturbance of the complete cover in the fifth tank.

In the Quercus dumosa series the evaporation-transpiration loss was only 46 percent of the seasonal precipitation. Since the foliage canopy on these five tanks is not yet complete, changes in treatment will not be undertaken for at least another season.

Woodland Cover

North Fork and Bass Lake Installations. The seasonal precipitation of 60.77 inches at North Fork was the highest on record since the start of rainfall measurement in 1904. Results from the run-off plots and lysimeters for the rain season 1937-38 are summarized in the following table:

Disposition of seasonal precipitation on plots and lysimeters

Vegetation treatment	Precipitation	Interception	Surface run-off	Evaporation transpiration	Percolation	Erosion per acre
	Inches depth	Inches depth	Inches depth	Inches depth	Inches depth	Pounds
Plots1/						
Undisturbed	60.77	3.28	0.01-	17.04	40.45	0
Twice burned2/	60.77	3/	2.19	3/	3/	814
Annually burned	60.77	3/	23.81	17.60	19.36	171,000
Lysimeters4/						
Bare soil	59.97	0.0	31.66	11.49	16.81	-
Litter cover, pine, 2 in.	59.97	0.0	1.59	6.84	51.54	-

1/ Plots in chaparral-woodland, 1/40th acre in area, 10 ft. wide, 108.9 ft. long, slope 32 percent.

2/ Vegetation burned in 1930 and in 1936.

3/ Not measured.

4/ Lysimeters 1000 sq. in. in area, 21 inches deep.

These results at North Fork substantiate in general those of past years in showing the considerable effect of natural vegetation, including litter, in reducing surface run-off and erosion, and in

increasing and maintaining the infiltration capacity of soils, even under a seasonal rainfall of exceptionally high intensities and total volume.

At Bass Lake six 1/40th-acre plots (two sets of three) in second growth ponderosa pine have been operated through four precipitation seasons with their natural cover undisturbed. During the first three years the average annual precipitation at the plots was 49 inches, about half of which came in the form of snow. In 1937-38 annual precipitation was 73 inches, nearly all in the form of rain. Notwithstanding the heavy rains of last season the average annual run-off from the plots for the 4-year period was only about one percent of the average annual precipitation.

Experimental treatment of these plots was begun in October by burning the litter and ground cover on one set of three plots, without any disturbance of the tree cover.

Intermountain

Grassland

Current records of soil eroded and surface run-off from watersheds A and B at the Great Basin Branch Station at Ephraim, Utah give additional convincing data regarding the effect of herbaceous plant cover on these phenomena. A condensed record of surface run-off and soil eroded (summer rains only) from these watersheds since their inception is shown in table 1. The data may be divided into three periods for consideration: (1) 1915 to 1929, (2) 1930 to 1935, (3) 1936 to 1938.

Technical Bulleting 220 (Forsling), "A Study of the Influence of Plant Cover on Surface Run-off and Soil Erosion in Relation to Grazing on the Wasatch Plateau in Utah," is a detailed report of the study for the period 1915 to 1929. During this period, as shown in the table, plant cover on watershed B was maintained at 40 percent of a complete cover, while that on watershed A was increased from 16 percent to 40 percent of a complete cover. During this 15-year period, while plant cover on watershed A was being built up from 16 percent to the 40 percent density of watershed B the A/B surface run-off ratio changed from 4.10 to 1.05 and the eroded material ratio changed from 5.42 to 2.48.

The narrowing of these ratios, as shown by the table, was largely (a result of decreased surface run-off and soil eroded on watershed A as) a result of increasing herbaceous plant cover density on watershed A. During the period from 1930 to 1935 inclusive, following the study reported by Forsling in Bulletin 220,

the plant cover on the two watersheds remained the same as during the previous 5-year period (1924-1929). However, eroded material decreased about 50 percent on both areas, and percentage of run-off on A and B was reduced to one-third and one-seventh respectively of that of the previous 5-year period. These decreases may have been due to restraining influence of accumulated litter, to precipitation conditions of the period or to both.

During the third period (1936-1938) management has been aimed at reversing the plant cover density on the two watersheds as compared with that which existed at the beginning of the study (1915-1920). Accordingly, watershed B was grazed heavily by sheep in 1936-37-38, which resulted in an average reduction of plant cover density from 39 percent to 28 percent. During this period the A/B surface run-off ration changed from 2.27 to 0.56, and the eroded material ratio changed from 2.50 to 0.55.

Briefly summarizing the complete history of the study to date, we find that while A and B plant cover densities were 16 percent and 40 percent of complete density, respectively, (1915-1920), watershed A produced 4.1 times as much surface run-off and 5.42 times as much eroded material as B. And when A and B plant cover densities were undergoing reversal (1936-1938) thus reducing B to an average of 28 percent density and maintaining A at an average of 42 percent density, surface run-off and soil erosion relationships also were reversed, watershed A producing only about 0.56 times as much surface run-off and 0.55 times as much eroded material as B.

Evidence of this kind is especially convincing because it completely nullifies criticisms that may have been aimed at the first phase of the study because of the lack of replication, and dissimilarities in size and physiography of the watersheds. Present trends of the study not only afford an opportunity for observing each watershed under widely different plant cover density conditions but the changed run-off and erosion results recorded concurrently with changed cover density conditions indicates that the condition of the plant and soil mantle on these two watersheds is a more important factor in controlling surface run-off and erosion than differences in such physiographic features as size, shape, slope, drainage pattern, etc.

Table 1.-Periodic annual percent of run-off and volume of eroded material from watersheds A & B, 1915-1938, inclusive, and changes in the A/B plant cover, run-off and silt ratios, Great Basin Station, Ephraim, Utah.

Period	Area "A"			Area "B"			A/B Ratios		
	Plant density	Run-off	Eroded Material	Plant density	Run-off	Eroded material	Plant density	Run-off	Eroded material
	percent	percent 1/	cu.ft. 1/	percent	percent 1/	cu.ft. 1/			
1915-1920	16	10.33	133.82	40	2.52	24.67	0.40	4.10	5.42
1921-1923	16-40	8.74	105.03	40	3.03	37.30	0.70	2.88	2.82
1924-1929	40	5.49	19.15	40	5.23	7.73	1.00	1.05	2.48
1930-1935	40	1.61	11.22	39	0.71	4.48	1.03	2.27	2.50
1936 2/	40	14.65	190.68	32	13.12	171.46	1.25	1.12	1.12
1937	39	11.05	536.76	24	6.35 3/	622.88	1.60	1.74	.862
1938	47	3.81	111.65	30	33.26 4/	727.72	1.59	.11	.153
1936-1938	42	9.84	279.69	28	17.57	503.35	1.47	.56	.555

1/ Based on effective precipitation.
2/ Grazing of area B in 1935 and 1936 followed the effective storms of these years, consequently 1936 data represent results following only 1 year of overgrazing on B.
3/ All run-off on area "B" in 1937 occurred before grazing.
4/ All run-off on area "B" in 1938 occurred after grazing.

Rocky Mountain

Forest

Interception study. In connection with a study of the influence of cutting lodgepole pine on snow storage and water yield, measurements have been taken of summer rainfall interception. Within each of twenty 5-acre cutting plots, a rain gage was located at random under an opening in the crown cover, the only limitation in selection being that the opening should exceed 50 feet in diameter. In each of the four cardinal directions another gage was placed exactly 1/2 chain from the central can. The location of each gage was described as to whether covered by a mature or immature crown or not covered; and, if not, the horizontal distance to the nearest crown was recorded. Between July and October 33 storms were recorded, varying in size from a trace to 1 1/4 inches.

A correlation analysis of the results showed a highly significant relation (R=0.63) between rainfall deficiency in interception gages ("X" = catch in central gage, minus catch in interception gage) and the two independent variables of storm size ("A") and degree of crown interference ("B"). The deficiency increased in strong direct proportion to size of storm, and decreased in much weaker proportion to decreasing crown influence (distance of gage from nearest crown), as expressed by the regression formula:

$$X = 0.2329A - 0.0121B + 0.0701.$$

Grassland

Portable plot study. Analysis of run-off records from portable plots is partly completed. Plots in the "valley bunchgrass" type show a good correlation between run-off and plant density ("R" = 0.78 for the 2-inch rain intensity series). In these analyses "available storage" is used as an independent variable to express soil variations. This factor consists, for any soil, of total pore space minus water content at the time of sampling. Its use in the analysis, however, accounts for only a small portion of the total variability.

Southwestern

Semi-desert Brush Cover

Value of Cacti for Soil Protection: Although cacti have earned a hard name for themselves, they have one redeeming feature in that they protect grass remnants and spots of soil on deteriorating ranges. This is plainly evident on many range areas where grasses are found only under the protection of cacti and other thorny

plants. Revegetation of many semidesert range areas is dependent upon these spots of grass and topsoil which have been protected by cacti and thorny shrubs. Without them, deterioration would have been complete, no vestige of forage would have been left.

The influence of these spots in retarding accelerated erosion is considerable, for they have the following effects:

1. Run-off from spots covered by cacti and herbs and grasses growing in their shelter is much less than from areas that are almost bare; thus they tend to check erosion along gullies and drainage channels, at least preventing it from becoming more destructive than it is already.

2. They check to some extent accelerated flow from higher ground by spreading and sinking run-off.

Several species of prickly pear conserve soil and check erosion by extending their stems along the surface of the ground catching litter and silt. As the pancake-like stems are enchored to the ground by roots they send into the soil, they function in effect as miniature check dams, being particularly effective where the direction of growth is at right angle to flow of surface run-off. Revegetation of grasses takes place naturally on the small silt pads that collect above the erosion checks formed by decumbent stems of the prickly pear. Thus natural revegetation is aided through the collection of seeds and alluvium and by the spreading and sinking of run-off.

In the consideration of measures for the control of cacti, the value which these plants have for soil protection should be taken into account. Where semidesert ranges are grazed to the degree that grass is depleted and natural revegetation of the herbaceous cover is prevented, the cacti should be preserved for the protection they afford to remaining grasses and topsoils. It might even be desirable to propagate prickly pear on areas that are in an extreme stage of deterioration in order to secure favorable conditions for revegetation of herbaceous plants.

STABILIZATION OF SOILS

Appalachian

Roads

Erosion Control on Fills. Field projects for roadside fixation on national forests, started during the early winter months in cooperation with Region 8, are being developed into an extensive program. An itinerary has been worked out by the national forest supervisors, and two representatives of Region 8 are training foremen and project superintendents with very gratifying results.

Among the particularly important problems brought out during this work is that of controlling erosion on fills. The practice of allowing the fills to erode as a natural process and using the gullies for dumping accumulated debris from roadside ditches has been an accepted custom which is difficult to change. Since many attempts to construct culvert outlets and gutters have been complete failures, the Experiment Station will study the most feasible method of establishing such outlets. Not only material and labor have been wasted, but serious loss of soil from the fills has continued, in spite of the present control attempts. A considerable part of fill erosion is due to the roadside ditch becoming stopped up with debris from the banks and accumulated water being turned across the road onto the fill at unprotected points. Frost action on light masonry construction laid on loose fills is proving particularly destructive. The increased cost of maintenance of fills, due to erosion, is becoming increasingly evident.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Methods

Benmore Experimental Tract Reseeded. During October and November, some 2,040 acres of abandoned dry-farm lands at Benmore, in southeastern Tooele County, Utah were seeded for prospective use as experimental pastures. These reseeded lands are part of a 3,500-acre tract tentatively set aside for research in rehabilitation and

grazing. Twenty-eight 100-acre pastures, a 240-acre holding pasture, a 160-acre field for plot trials and a headquarters area were fenced and the pastures provided with livestock watering facilities.

Eighteen of the 100-acre pastures were drilled with a mixture of crested wheatgrass, slender wheatgrass, western wheatgrass, smooth bromegrass, and tall oatgrass, the species that previous trials have shown are best suited for such conditions. About half of the holding pasture was drilled and the remainder, still in original sagebrush, was broadcast and trampled by livestock. It is planned to prepare the remainder of the pastures and seed it next season.

This experimental tract is part of a 40,000 acre purchase unit under the old Resettlement Administration in southeastern Tooele County and in the adjacent part of Juab County. Range improvements were developed preparatory to turning most of the area into an administrative grazing unit, now under the Soil Conservation Service. Part of the project development, however, was the experimental reseeding unit, where is proposed to study both artificial reseeding on abandoned farm lands and grazing of successfully reseeded areas.

Part of the experimental area had been plowed so it seemed advisable to plow the remainder before attempting a uniform seeding of the proposed pasture for a grazing experiment. Seeds, bought with emergency funds, were drilled under the direction of the project staff. The Intermountain Station provided technical help in calibrating drills and in providing drilling instructions. The details of the experiment are to be worked out cooperatively between the Intermountain Station, the Utah Experiment Station, and the Soil Conservation Service.

Northern Rocky Mountain

Species

Crested wheatgrass has almost tripled (185 percent increase) the weight of palatable forage on eight areas aggregating about 21 acres reseeded during the past few years. This comparison is based on air-dry clippings made on 40 paired plots, half of which were from reseeded and half from adjacent similar but unreseeded portions of these areas. They were reseeded 2 to 5 years before the clippings were made and represent an average of less than four growing seasons.

The average yield of crested wheatgrass on seeded plots was at the rate of 1,528 pounds per acre, nearly 80 percent of

the yield of all species combined. Most of the increase in crested wheatgrass production has been made at the expense of Russian thistle and downy brome. On unreseeded plots, downy brome and weeds, mainly Russian thisle, yielded at the rate of 429 and 683 pounds per acre while on adjacent plots, which had been reseeded, these species of low value were reduced to 32 and 286 pounds per acre, respectively. From the beginning it has been clear that crested wheatgrass would quickly replace Russian thistle but downy brome gave more competition because it starts spring growth as early as crested wheatgrass. It now seems evident that crested wheatgrass can more than hold its own with downy brome. The chances for controlling downy brome by replacing it with a more valuable grass thus seems very promising.

On the eight areas sampled as above, little or no soil preparation was made for seeding. Five of the eight were on plowed and abandoned land and three were on unplowed national forest areas with depleted native vegetation.

Examinations made in 1938 indicate that stands of crested wheatgrass reseeded during recent drought years have continued to improve in 1937 and 1938. Approximately 1,250 acres have been reseeded on 43 cooperative ranch areas and 39 of these ranches have a stand classed as successful on some portion. Fall seeding continues to show better success than spring seeding.

Southwestern

Methods

Effects of artificial litter upon the germination of grass seeds. Previous tests on the Santa Rita Experimental Range have shown that the germination of grass seeds on deteriorated barren soils can be greatly increased through the application of artificial litter in the form of straw or hay. The effects of various kinds of litter upon the germination of grass seeds were compared in 1938. The test was of the randomized block design in which individual treatment plots 1 foot square and separated by isolation strips 2 feet wide were used. Seeds of 10 native forage grasses were planted under 8 different treatments, with each treatment replicated 3 times for each species. Equal amounts of seed containing material were used for all treatments for each particular species of grass and comparisons of the effects of the different treatments upon a given species are therefore permissible. Due to the fact that uncleaned seed material was used, there was considerable variation in the purity of the seeds of the various species planted, so that the results are comparable between species only in a very general way. Liberal amounts of seed were purposely applied to assure some germination under the less favorable treatments. Results of the tests are summarized in the following table.

Germination of various range grass seeds under different treatments

Treatment	Boute-loua eriopoda	B. Roth-rockii	B. Chondros-ioides	B. Fili-formis	B. Hirsuta	Aris-tida divar-icata	A. Glab-rata	Tricha-chne calif-ornica	Hetero-pogon contortus	Hila-ria belan-geri	Total all species
	number	number	number	number	number	number	number	number	number	number	number
None	6	3	2	1	18	8	14	1	15	0	68
Raked lightly	19	5	7	16	110	62	50	8	45	0	322
Covered with straw	26	7	37	53	203	203	38	32	66	2	667
Covered with burroweed 2/	46	10	14	17	223	143	36	196	54	4	743
Covered with open-mesh gauze	86	43	47	196	400	283	132	313	88	5	1,593
Raked lightly and covered with straw	23	5	16	144	240	183	49	60	104	6	830
Raked lightly and covered with burro-weed	21	14	22	137	250	167	55	105	98	3	872
Raked lightly and covered with open-mesh gauze	84	27	62	117	517	240	115	203	62	2	1,429

1/ Expressed in number of seedlings per square foot plot. Average of 3 replications.

2/ Burroweed plants broken and chopped to form litter.

Using the results of seeding on bare untreated ground as a basis of comparison, light cultivation or raking to loosen the soil and cover the seeds increased germination about 5 times, while covering the seeds with burroweed and straw litter each increased germination about 10 times over that on the untreated plots. The greatest germination in all cases occurred under the open-mesh gauze where the total number of seedlings was about 25 times as great as on the untreated ground. Raking, on plots later covered with the three different forms of litter, did not materially increase germination over that on the plots covered with litter and not raked. These results are for germination and emergence only, and do not necessarily indicate the final survival of seedlings on the various plots. There will undoubtedly be a high mortality due to competition on the plots which produced large numbers of seedlings. It appears that any form of material which will partially shade the ground and retard the drying of the surface soil will greatly increase germination of grass seeds. With further study it may be possible to incorporate the use of chopped stems of such plants as burroweed, snakeweed, and other worthless shrubs into a combined program of weed control and range revegetation.

At the present time it would seem that any basic plan to improve deteriorated semidesert ranges through natural reseeding should include a system of management which will result in the accumulation and maintenance of some form of litter cover on the ground.

GRAZING MANAGEMENT

California

Spring-Fall Ranges

The faster "get-away" of growth of new feed wherever it is protected by some old dry material left over from the preceding year, compared with "slicked-off" areas, was repeatedly observed during the two-year period of scouting the Sierra Nevada foothills prior to the establishment of the San Joaquin Experimental Range. This contrast has also been consistent during the past three seasons on the Experimental Range, both between closely grazed and moderately grazed pastures, and between closely and moderately grazed spots in a single pasture.

Recent measurements (December 30) are indicative of the amount of this difference in this annual type during the past season, as observed on 120 temporary sample plots representing the two

intensities of grazing along with northerly and southerly exposures, as summarized in the following table:

Height of new feed, in inches, with and without protecting old growth

Area	Broadleaved herbs chiefly Erodium		Annual grasses		Average of all new growth	
	Old growth	No old growth	Old growth	No old growth	Old growth	No old growth
Moderately grazed pasture						
N. exp.	1.5	.4	3.7	1.6	2.6	1.0
S. exp.	1.4	.5	3.1	1.2	2.2	0.8
Closely grazed pasture						
N. exp.	.9	.4	2.6	1.1	1.7	0.7
S. exp.	.7	.2	2.2	.9	1.4	0.5
Averages	1.1	.4	2.9	1.2	2.0	.7

On these samples, height of all new growth averaged 2.6 times greater on moderately grazed areas, the ratio being 2.9 to 1 for "filaree" and associated broadleaved herbs, and 2.4 to 1 for the several species of annual grasses. This preliminary indication bears directly on the broad relations of intensity of use to grazing season and to grazing capacity - one of the major objectives of our range program.

Northern Rocky Mountain

Shortgrass Ranges

Shortgrass ranges that reached the low point of the drought early in 1937 made a splendid recovery in the following year under all three intensities of grazing. Precipitation was close to normal at Miles City during the last half of 1937 and the spring of 1938 was very favorable. As a result, the density of vegetation on Miles City quadrats early in 1938 was more than double that of 1937, according to recent compilations. However, the total density now stands at slightly below 25 percent of the 1933 level. Grama grass nearly doubled its density during the year but has lost its place of dominance of Sandberg bluegrass. This little bluegrass has increased in density of cover more than fivefold since 1933 and is partially responsible

for overly optimistic statements about range recovery. It is a splendid spring forage and sometimes provides fall feed, but it has but limited value for summer or winter forage. Cactus, Opuntia, polyacantha, has increased more than fivefold on quadrats since 1933 and is the cause for some concern.

Oddly enough, recovery appears to be proceeding as rapidly, if not more so, on overgrazed as on lightly grazed ranges. Despite the increased height growth and more than doubling of the 1937 density, these ranges are far below their 1933 level of density. This should be recognized in any program of restocking drought-depleted ranges.

Pacific Northwest

Summer Ranges

Soil Losses and Grazing Capacity. The relationship between the presence of topsoil and grazing capacity is demonstrated by a study made on an open grassland range in the Wallowa Mountains. The topsoil on the area, being of very fine texture, is easily eroded except where it is held together in large blocks by the matted roots of green fescue (Festuca viridula). These root mats are such effective impediments to erosion that after the green fescue plants have been killed by overgrazing or by other causes the dead roots may continue to hold the topsoil for some time. Analysis to show changes in grazing capacity with decrease of topsoil on 563 plots showed that on plots with topsoil on 51 to 75 percent of the ground surface the average grazing capacity was 1.2 times that on plots with topsoil on 26 to 50 percent of the ground surface, 2.3 times that on plots with topsoil on 1 to 25 percent of the ground surface, and 4.7 times that on plots from which all the topsoil had been removed. The same comparisons for the change in total density were 1.2, 1.7, and 2.2 times, respectively. The greater proportional reduction in grazing capacity than density with the reduction in topsoil is the result of an increase in species of lower palatability with the decrease of the highly palatable green fescue.

Utilization Standards. The green fescue subalpine needlegrass (Stipa columbiana) association which occurs at high elevations in the Cascade and Blue Mountains in Region 6 is an important type on many summer sheep allotments. Tentative standards of utilization have been established for the type. The green fescue type is thought to be near climax for open ranges in the Hudsonian life zone in Region 6. In the Wallowa Mountains of Oregon it is found in its best condition, where it is composed chiefly of green fescue with a mixture of subalpine needlegrass, various sedges (Carex spp.), and many minor grass and weed species. Sometimes a species of lupine (Lupinus sp.) occurs in considerable amounts. Green fescue is highly palatable to sheep,

being more palatable than other species in the association, and furnishes by far the greatest amount of feed. In the interest of both forage production and soil stability, the objective in managing this forage type should be to maintain it in as nearly climax condition as possible. Studies on experimental areas indicate that to do this a maximum of 50 percent (by weight) of the current herbage of the green fescue can be utilized. This will leave an average height of stubble of 3 inches following grazing. Under this degree of use subalpine needlegrass will be used approximately 15 percent, fleeceflower (Aconogonum phytolaccaefolium) will be used approximately 5 percent, and shrubs as a class will be virtually unutilized.

Rocky Mountain

Range Ecology Study Course. A study course consisting of 10 lessons on Range Ecology has been prepared for supervisors and rangers in Region 2. This course discusses some of the ecological concepts of practical value to the range administrator and presents some of the important relationships of the vegetation to its habitat; including grazing. The numerous specific examples given are based primarily on information gathered in Colorado and Wyoming. Field problems involving type descriptions, simple clipping studies, plot observations, and investigations of plant competition also are included. Representative forage types and range conditions are illustrated by photographs.

Noxious Plant Control

Orange sneezeweed investigation. The 1938 studies in western Colorado revealed that the plant species most frequently and intimately associated with orange sneezeweed are, in approximate order: western yarrow (Achillea lanulosa), dandelion (Leontodon taraxacum), slender wheatgrass (Agropyron pauciflorum), cinquefoil (Pontentilla gracilis), peavine (Lathyrus sp.) letterman needlegrass (Stipa lettermani), Richardson geranium (Geranium richardsonii), lupine (Lupinus sp.), wild daisy (Erigeron subtrinervis), and trisetum (Trisetum montanum).

As stated in a former report, orange sneezeweed maintains its stand primarily by offshoots arising from buds that form on the taproot of plants that flowered the current season. In 1938, the adventitious buds became evident in late August; the offshoots were produced throughout September, and were green until about October 10. Other herbaceous plants were frost-killed before this date. More recent evidence indicates that sneezeweed rosettes remain green throughout the winter.

Specimens of orange sneezeweed were transplanted in September to a lower elevation (5000 feet) for winter observation. Several rows of these plants were covered with weed-hay material to protect them from low air temperatures. The new offshoots continued to develop for about three weeks. Growth stopped about October 15, but most of the rosettes were green until November 10. By January 17, 1939, all exposed leaves had been killed (probably in December), but the rosettes that were covered with hay were still green; one unmulched plant that had been covered with 3 to 6 inches of snow was still green.

Some of the protected plants were still green on January 31, although the soil around them was frozen. Minimum air temperatures during this period ranged from well above freezing to -8.9° F., freezing temperatures nearly every night.

The major point is that orange sneezeweed plants remained green during November, December, and January when protected by a thin cover of hay material or snow. Therefore, it is quite probable that sneezeweed rosettes remain green throughout the winter at high elevations where protected by a heavy blanket of snow. Field observation will be needed before the snow melts to check on this observation. If this is true, orange sneezeweed gets a much earlier (at least more efficient) start in the spring than associated herbs.

Southwestern

Year-Long Ranges

Patented Lands Within Jornada Acquired. Ever since the creation of the "Jornada Range Reserve" by Executive Order in 1912, eight 40-acre tracts of land, upon which have been located the major water developments, have been privately owned, first by C. T. Turney and then by W. H. Waggoner. This situation has through the years restricted the choice of the cooperator on the Jornada to the owner of these patented lands or a third party agreeable to him as well as to the Forest Service. The private ownership status of these lands has also set up other hinderances and complications to the orderly administration, improvement, and use of the Jornada as an experimental range.

Probably the outstanding happening of the past year is the transfer to the United States of the patent of these lands, together with the ownership of all unliquidated improvements thereon, all miscellaneous ranch equipment, and a number of horses. This outcome of negotiations extending over a number of years, also resulted in the execution of a new cooperative agreement between Waggoner and the Secretary of Agriculture as of October 1, 1938. This new agreement cancels all privileges and unliquidated credits under the old

agreement and provides grazing privileges to the extent of 12,000 cattle years to B. A. Christmas, as authorized agent of W. H. Waggoner, over a period of 10 years ending June 30, 1948. At that time, or sooner if the 12,000 cattle years of grazing privileges have been liquidated, a new agreement will be entered into with B. A. Christmas as principal, under which the grazing privileges will be valued at $3.00 per head yearly, either in the form of the construction of new improvements as needed with grazing credit allowed, or in cash paid into the cooperative work fund, or both. In addition, the cost of the current repair and upkeep of all range improvements will be borne by the cooperator.

The Works Progress Administration approved an application for a construction program on the Jornada Experimental Range involving an average of 30 men for a period of 1 year or more, under the usual terms of such State projects. The program includes both construction and betterment of existing facilities and much technical development and operations, such as surveys, revegetation, forage restoration, etc. The WPA State Office has also signified its willingness to recommend an additional 12-man "white collar" program for the compilation of range data.

Ponderosa Pine Ranges

Sampling Vegetation. Line transects have been used occasionally as a method for sampling vegetation on range areas. In the line transect method, the determination of the amount of ground occupied by the different species within a type is based on actual measurements of plants occurring on lines instead of the usual ocular estimates of the vegetation made by the range examiner.

During the 1938 field season the line transect method was employed in sampling the forage cover of the Wild Bill Cattle Allotment of the Kaibab National Forest. This allotment contains some 24,000 acres of cut-over land supporting 20-year-old ponderosa pine reproduction and a mixture of grasses and weeds. A preliminary analysis of the data indicates that the method may have considerable merit.

Objectives of the project were:

1. To obtain an estimate of the area of ground actually occupied by forage plants based on actual measurement.

2. To start a series of measurements that will eventually be used to determine the influence of the different age classes of ponderosa pine reproduction on the character and abundance of forage plants.

One transect 50 feet long was located at random within each 320 acres or major fraction thereof. The transects falling in the east and west halves of the section were designated as "A" and "B", respectively. Measurements at ground level to the nearest 0.01 foot were recorded by species for all plants intercepted. Results obtained from a preliminary analysis of the data are:

1. The difference between the means of 41 A transects and 47 B transects (summarized in table 1) tested non-significant in all cases giving a value for t that was far below the 5 percent level. The difference of only 0.008 feet between the means of total vegetation is probably a coincidence, although observations made in the field and all statistical tests applied in the analysis of the data indicate a high degree of homogeneity throughout the area.

Table 1.—Comparison of A and B transects - mean feet of vegetation intercepted

	Festuca arizonica	Muhlenbergia montana	Other grasses	Total grasses	Weeds	Total vegetation
A transects	1.99	4.44	0.81	7.24	1.04	8.288
B transects	1.79	4.64	1.05	7.48	0.80	8.280
Difference	0.20	-0.20	-0.23	-0.24	0.24	0.008

2. Results obtained, when the A and B transects are included in one array of 88 observations, are as presented in table 2.

Table 2.—Summary of data from 88 transects

Mean feet of	Festuca arizonica	Muhlenbergia montana	Other grasses	Total grasses	Weeds	Total vegetation
vegetation intercepted by line	1.88 ±.20	4.55 ±.33	0.94 ±.13	7.37 ±.46	91 ± 11	8.34 ± .54
Percent of ground occupied	3.96	9.10	1.88	14.75	1.82	16.68
Percent of composition	23.00	55.00	11.00	(89.00)	11.00	100.00

As measured by the low values obtained for the standard errors, means of the measurements for species and forage classes of vegetation all test "highly significant", indicating that with confidence a high degree of reliability may be accorded even the more scantily represented ones.

Handling Live Stock

Jornada Calf Crop. The 1937 record Jornada calf crop of 90 percent has been broken by a still greater calf crop of 92 percent for the calendar year 1938. While rainfall and consequent forage growth are of considerable importance in calf crop production, yet the records for 1936 and 1937 indicate that it is not necessary to have extra heavy rainfaill and forage growth to produce large calf crops.

The forage produced during the growing season of 1936 was about 8 percent less than "normal". The summer rainfall for this year was 14 percent greater than average but some of it was ineffective owing to poor distribution throughout the season. In spite of "below normal" forage production during the 1936 breeding season, the 1937 calf crop was 90 percent.

In 1937 the summer rainfall was only 8 percent below average and so satisfactory was its distribution that the estimated forage crop was only 5 percent below "normal". But again these near average conditions during the breeding season preceded the 92 percent calf production in 1938.

The breeding cows were not fed during these years but were maintained in good breeding condition entirely by grazing on the range under close supervision. However, most of the bulls were fed concentrates a part of the winter and spring months preceding each breeding season.

High calf crops without extraordinary conditions can be obtained by taking advantage of all the "breaks" of the average year through proper seasonal use and distribution of stock on the range. Also by other familiar measures such as close culling of herbs to remove unproductive animals and plenty of good vigorous bulls.

COOPERATING BUREAU PROJECTS

BIOLOGY
(In Cooperation With the Bureau of Biological Survey)

California

Rodent Biology and Ecology (San Joaquin Experimental Range). The residual vegetation on the rodent plots was clipped prior to the start of fall rains and weighed. The results are:

Plot	Kind of animal	Number per acre	Weight of vegetation pounds per acre				
			Forage produced	Eaten	Per rodent	Tarweed	Turkey Mullein
I	Ground squirrel	12	1855	546	45	249	1.6
II	Pocket gopher	16	1923	478	30	189	2.0
III	None	Check area	2401	-	-	357	2.0
IV	Kangaroo rat	32	1414	987	31	407	-
V	All rodents	Unknown	1531	870	-	412	-
VI	Livestock and rodents	Unknown	896	1505	-	384	6.1

Plot III, totally protected, is accepted, for the purpose of preliminary analysis, as yielding the potential forage for each plot. The difference in residual weights between plot III and each of the other plots, indicates the poundage eaten or destroyed by the animals having access to the several plots.

The pounds of forage per individual rodent of each species may be applicable only when the rodent population is at the density of this experiment. It will be necessary, later, to determine what amount is eaten or destroyed per rodent of a varying density of population. Application of these figures to the entire range demands further data, now being secured, on the number of each species of rodent, and both the qualitative and quantitative figures of the forage species taken by the several rodents.

Fitch has followed individual ground squirrels quite intensively, and found that food preferences change quite rapidly, seasonally, and roughly is in the order of seed ripening, species by species. The acceptance from March 20, 1938 to January 15, 1939, is as follows:

March 20 to 31 - green material, mainly flowers and young fruits of filaree.

April 1 to 14 - filaree fruits and seeds; tarweed and Lotus leaves.

April 15 to 30 - mainly filaree seeds.

May 1 to 15 - flowers of Gilia tricolor, filaree seeds, popcorn flower seeds, clover blossoms.

May 15 to 30 - grass seeds (Avena barbata, Bromus rigidus, Hordeum murinum); seeds of Silene gallica and Erodium botrys; fruits of Erodium cicutarium.

June 1 to 15 - seeds of Hemizonia wrightii, Silene gallica, Hordeum murinum, and Bromus rigidus; flowers and fruits of Godetia.

June 15 to 30 - foliage of lythrum; stems and fruits of filaree and Lotus americanus, Ceanothus cuneatus fruits, digger pine seeds.

July 1 to 15 - leaves of Hemizonia virgata and Lythrum, green pods of Lotus, seeds of Navarretia, digger pine seeds.

July 15 to 30 - Live-oak acorns, foliage of Lythrum.

August 1 to 31 - Live-oak acorns, cast seeds of Bromus rigidus. Staminate flowers of turkey mullein.

September 1 to 30 - Tarweed (H. virgata) seeds, acorns, seeds of turkey mullein and B. rigidus.

October 1 to 31 - Tarweed seeds, acorns, B. rigidus seeds.

November 1 to 30 - Acorns; new green vegetation (Bromus, Festuca, Erodium).

December 1 to 31 - Green material (Bromus, Festuca, Erodium), acorns.

January 1 to 15 - Variety of green material (filaree leaves preferred; also Bromus, Festuca, Plagiobothrys, Amsinckia, Hordeum, Calendrinia, Nemophila).

Kangaroo rats, during the dry season, take squirreltail fescue (Festuca megalura) and soft chess (Bromus mollis) in preference to other seed.

Food items taken from 118 rattlesnakes include: Cottontails (young), ground squirrels, mice (Peromyscus and Perognathus), kangaroo rats, and pocket gophers in about that order of importance, except that lizards (of several species) are the principal prey of young snakes. One rattlesnake to each three acres is about the population on one part of the range that is not the best snake habitat. Hence, the figure is conservative.

Of various methods of marking rodents, numbered aluminum tags placed in the ears have been most successful. Toe clipping, ear punching, and dyeing of the entire animal with aniline dye were tested.

Nearly all squirrels on 40 acres of pasture I have been tagged. Recaptured and observed marked squirrels show that some individuals use the same burrow system for periods of months, staying within an area of at most, a few hundred feet. Others have moved their living quarters over 200 yards.

Squirrels are emerging from hibernation during latter January. One adult female hibernated from November 29, 1938 to January 18, 1939, a period of 50 days.

Marked kangaroo rats likewise are confined to a small foraging area of less than 100 feet across. One rat was recaptured, however, more than a mile from the point where it was originally taken.

Coyote-deer Study (Los Padres National Forest). Through provisions of a Biological Survey sponsored WPA project, a collector was placed in Mono Basin on December 8, 1938, to make a biological survey of the study area, and to make a reference collection of the birds, mammals, reptiles and amphibians. During December, 35 mammal skins were prepared. Distribution of rodents so far recorded is: 1. Old CCC camp site, weedy area grazed by mules and deer negligible catch. 2. Mono Creek Bank; 43 percent catch (on trap night basis) of two species of white-footed mice and the common house mouse. 3. A dry wash; 50 percent catch of white-footed mice and wood rats. The catch decreased markedly as the wash progressed uphill from a road. 4. Line midway between ridge and Mono Creek yielded a 20 percent catch of white-footed mice. The ridge top catch was very slight.

Total December catch consisted of 111 white-footed mice of three different species, eight wood rats of two species, one each of two species of kangaroo rats, seven pocket gophers, and one ground squirrel.

Forty-one hundred coyote skats have been analyzed. A surprisingly high percentage contain large quantities of deer hair, although deer hair in a skat does not prove that the coyote killed the deer.

Fawn survival on the area from which coyotes were trapped prior to the fawning season was much higher than during the preceding year when coyotes were present. Comparative figures for totally untrapped areas are not yet available, but the indication is a greater survival on the trapped area.

Results of Initial Test of Controlled Quail Hunting

A new phase of the 4-agency cooperative quail-management study was completed during December. To furnish information on the effects of hunting, a 1,4440-acre hunting-management unit was established on the San Joaquin Experimental Range - 720 acres for hunting and 720 acres as aprotected population check area. A horseback census on November 8 and 9 indicated 513 quail on the hunting area and 349 on the control area. It was planned to take off about 25 percent of the birds, and observe the results.

Parties of from two to five hunters, selected by the Madera County Sportsmen's Association, shot over the area at about weekly intervals throughout the quail season. A total of 136 quail - 26.5 percent of the original total of 513 birds - was taken; 57 additional birds were reported as nonrecoverable cripples. The crippling loss for hunters without dogs was nearly four times that of the hunters who used dogs for retrievers. The total loss of birds over the area was 193 birds, or 37.6 percent of the original population. Twenty-one hunters spent a total of 96.8 hours of hunting effort on the area, or an average of 4.6 hours per man. This effort resulted in 1.4 birds per man hour. Each man used an average of 23.8 shells per hunt, or 3.67 shells for each bird in the bag.

Southwestern

Methods of Poisoning Rodents: At the request of this Station, the Bureau of Biological Survey undertook during the summer of 1938 at Cloudcroft a study to detetmine the efficiency of different poisons for controlling rodents. Both strychnine and thallium, applied to different kinds of grain and vegetables as bait, were tested, including rolled oats, oat groats, apples, sweet potatoes, and hulled sunflower seeds. The study included also testing merits of so-called "permanent stations," which provide for constantly available bait so placed as to be accessible to rodents but not to other kinds of animal life. Following

is a summary of results as given in a progress report prepared by Mr. Jack F. Welch, District Investigator of the Control Methods Research Laboratory at Denver:

1. Strychnine: Generally speaking the strychnine poisoned baits did not give promising results, either by increasing the strychnine concentration, or the quantity of bait exposed, or by concentrated bait placements.

2. Thallium: So treated hulled sunflower seeds and rolled oat groats baits both gave very satisfactory results. No rodents were taken on areas after treatment with the former and less than a 2 percent catch on the latter.

3. Hibernation of Peromyscus: There is indication of a period of hibernation on the part of the Peromyscus is early fall and until more complete data is available the practicability of control work at that time is questionable. The possibility is the permanent station, should it protect the bait until the spring activity again.

4. Reinfestation: There is indication that areas free of slash are much more slowly reinfested, after removal of rodents, particularly mice, than are those areas containing considerable rodent harbor.

5. Permanent Station: The possibilities of the station can be more freely commented upon after examination in the spring. Indications of their use by rodents was observed in tests made in the fall. From a standpoint of availability, usefulness, and cost, the quart oil cans appear to have the greatest possibilities. It was observed that the paper tubes were molested, being moved and torn, apparently by squirrels. The wood stations are more expensive to prepare, also, they are much more bulky and heavy to handle.

If future experiments with thallium show this poison to be as immediately and as thoroughly effective as indicated by the results of the present study, an economic solution to the rodent problem in the Cloudcroft region will have been found. This is because results of other experiments have shown that rodents do not molest Douglas fir seedlings very much after they are a year old; consequently, it would probably not be necessary to poison areas more than once. To prevent destruction of seed, areas to be naturally restocked would be poisoned prior to the occurrence of seed crops, and areas to be artificially regenerated, prior to broadcast sowing or seed spotting. Further studies in cooperation with the Biological Survey are planned.

ENTOMOLOGY
(In Cooperation With the Bureau of Entomology & Plant Quarantine)

Southern

Powder-Post Beetles. Christian reports progress on the powder-post beetle project at Tallulah, La.; adults are emerging from wood in the constant temperature chamber.

Termites. Progress is being made on the soil poisoning project for the control of subterranean termites; at this season of the year there is very little activity but as soon as termites begin to fly, we will be able to operate more continuously.

Snyder and Johnston spent some time working on the manual of the forest insects of eastern United States.

PATHOLOGY
(In Cooperation With the Bureau of Plant Industry)

Southern

Native Canker-Forming Rusts. In December several of the permanent rust study plots were reexamined and a reexamination of the slash and longleaf pine seedlings at the W. W. Ashe Nursery was started. The examination of the plots revealed numerous rust infections one year old and a few that had started in the spring and summer of 1938. These infections were on trees that were planted in 1935 and 1936. The results of the work in the nursery indicate that a small percentage of the longleaf pine seedlings are infected with the oak pine rust.

The month of January was spent making nursery examinations in Federal and State nurseries in Louisiana, Mississippi, Alabama, Georgia, and Florida and in establishing a plantation of healthy and diseased slash pine seedlings on the Harrison Experimental Forest in Mississippi. The results of the nursery survey indicate that the percentage of slash pine seedlings infected with rust was approximately the same at lifting time as it was in September. Infected longleaf pine seedlings were found in several nurseries and in one of these the loss due to rust infection will probably be 12-15 percent. Plans are being made for cooperative work to be carried out this season in several of these nurseries.

PUBLICATIONS

MANUSCRIPTS

California

Burks, Geo. and Wilson, R. C.	Vegetation inventory from aerial photographs. (For Photogrammetric Engineering.)
Hall, J. A.	The slab pile and logging waste. (For Journal of Forestry.)
Righter, F. I.	"Early Flower Production Among the Pines" (For Journal of Forestry.)
Schreiber, Beryl O.	A new species of Helianthemum from California. (For April Madrono.)
Stockwell, W. P.	Preembryonic selection in the pines. (For Journal of Forestry.)

Lake States

Girard, James W. and Gevorkiantz, Suren R.	Timber Cruising. (For U.S.D.A. Technical Bulletin)

Northeastern

Behre, C. Edward	"The Opportunity for Forestry Practice in the Control of Gypsy Moth on Wild Lands in Massachusetts." (For Journal of Forestry.)

Pacific Northwest

Briegleb, P. A.	Growth and mortality in second-growth spruce-hemlock stands of Clatsop County. Report on the 1938 remeasurements of the Clatsop permanent sample plots nos. 1, 2, 3, and 4.

Kachin, Theodore and Welch, D. C.	Spot thinning demonstration in ponderosa pine. Report on establishment of Whitman thinning plot no. 5. Dec. 1938.
_____	Stand improvement technique and organization for ponderosa pine forest. Dec. 1938.
Morris, W. G.	What is average bad? (For Fire Control Notes. Jan. 1939)
_____	Roads plus people, equals fires. (For American Forests.)

Rocky Mountain

Cassady, J. F.	Certain ecological characteristics of orange sneezeweed. (To Ecology)
Costello, D. F.	Range-Ecology--A Study Course. (Mimeographed.)
Costello, D. F. and Klipple, G.	Sampling intensity in vegetation surveys made by the plot method. (To Journal of Agronomy)
Taylor, R. F.	The application of a tree classification in marking lodgepole pine for selection cutting. (To Journal of Forestry)

Southern

Bull, Henry	"Loblolly Pine vs. Cotton: A Comparison of Annual Cellulose Production Per Acre" (For journal of Forestry.)
Liefeld, T. A.	"How Long will a Streak Yield Gum?" (For Naval Stores Review)
Wahlenberg, W. G.	Methods of forecasting timber growth in irregular stands (For Journal of Forestry.)

Southwestern

Little, Elbert L., Jr.	Botrychium lanceolatum in Arizona. (For American Fern Journal.)
Pearson, G. A.	Review "The Forests of Sweden." (For Journal of Forestry.)

MIMEOGRAPHED RESEARCH NOTES

Southwestern

No. 42. Effect of high pruning on the diameter growth and taper of ponderosa pine.

No. 43. Seedlings safe from rodent destruction after a year's protection.

No. 44. Tentative range utilization standards - Bluestem (Agropyron smithii).

No. 45. Southwestern species of agave.

No. 46. The earliest stages of pinon cones.

No. 47. Mexican pinon (Pinus cembroides).

No. 48. Food analyses of pinon nuts (A compilation of existing data).

No. 49. Does screening of seed spots do more than protect the spots against rodents and birds?

No. 50. Stages of growth of pinons in 1938.

No. 51. Growth after cutting in ponderosa pine.

IN PRINT

Abell, C. A.	Stripping brushfields for planting in California. (Journal of Wildlife Management, October, 1938.)

Anderson, I. V. and Rapraeger, E. F.	The Christmas Tree Industry. (Processed)
Ares, Fred N.	Cutting tobosa grass for hay. (The Cattleman. February 1939.)
————	Electric fence effective on range. (American Hereford Journal, January 1, 1939; American Cattle Producer, February 1939.)
Austin, L.	Work of the Institute of Forest Genetics. (Planting Quarterly July 1, 1938. Mimeographed.)
Auten, John T.	"A Forest Soil Research Program for the Central States." (Journal of Forestry, February 1939.)
Aylesworth, E.	Summary of address on Dr. R. A. Fisher's approach in statistical methodology. (Presented before the San Francisco Chapter of American Statistical Association, March 3, 1938. San Francisco, California, 1938. Mimeographed.)
Bliss, E. Shirley	Tree oaks of the Southwest. (Journal of Forestry - Briefer Articles. December 1938.)
Bruce, H. D.	"Sterilizing Soil with Chemicals for Firebreak Maintenance." (Fire Control Notes, Vol. 3, No. 1, January 1939.)
Bruce, H. D.	Experiments with chemicals for control of vegetation. Berkeley, California, 1938. Mimeographed. Instructions in the use of chemicals for sterilizing soil. Berkeley, California, 1938. Mimeographed. (For National Forest officers; not for general distribution.) Sterilizing soil with chemicals for firebreak maintenance. (Fire Control Notes, January 1939.)

Buell, E. D.	Forest statistics for Columbia County, Oregon. Mimeographed.
Bull, Henry	Board-foot growth after improvement cutting (Southern Lumberman, December 15, 1938.)
California Station Staff	Guide to the Blacks Mountain Experimental Forest; a sustained yield experiment in ponderosa pine in northeastern California. Berkeley, California, 1938.
Campbell, R. S. and Campbell, Imogene Foltz	Vegetation of gypsum soils of the Jornada Plain. (Ecology. October 1938.)
Crafts, Edward C.	Side-oats grama is important forage grass. (Arizona Stockman, January 1939.)
Cunningham, R. N.	Preliminary Figures from Lake States Forest Survey. (Journal Forestry, January 1939.)
Demmon, E. L.	Research results in southern forestry. (Occasional Paper No. 77. December 1, 1938.)
Garver, R. D.	"The National Timber Stand." Journal of Forestry, February 1939.
Glading, Ben	Studies on the nesting cycle of the California valley quail in 1937. (California Fish and Game, October 1938.)
Gleason, C. H.	Portable tracing table. (Construction Hints, January 22, 1938.)
Hallauer, Frank J.	Pitfalls in Interpreting Lumber Consumption Trends. (Journal of Forestry, January 1939.)
Hasel, A. A.	Methods-of-cutting demonstration plots. Berkeley, California, 1938. Mimeographed. Sampling error in timber surveys. (Journal of Agricultural Research, November 15, 1938.)

Hepting, G. H., and Chapman, A. D. — Losses from heart rot in two shortleaf and loblolly pine stands. (Journal of Forestry, December 1938.)

Hurtt, Leon C. — Downy brome (cheatgrass) range for horses. (Applied Forestry Note No. 89. Mimeographed.)

Jacot, A. P. — Four new Arthropods from New England, (Am. Midl. Nat., 20:571-574.)

_____ — The Geenton Mites of Florida (Grossman Collection--III), (Fla. Ent., 21:49-57)

Jemison, George M. — "Determination of the Rate of Spread of Fire in the Southern Appalachians." (Fire Control Notes, January 1939.)

Johnson, H. M. — Trends in lumber production in Oregon and Washington. (The Timberman, January 1939.)

_____ — Average western wholesale prices per square of western red cedar shingles, f.o.b. mill, Oregon, Washington, and British Columbia, 1938. Mimeographed.)

Kotok, E. I. — Watershed-management from the viewpoint of the forester. (American Geophysical Union. Transactions. 1938.)

Krauch, Hermann — Use of protective screens in seedspot sowing found to serve twofold purpose. (Journal of Forestry, December 1938.)

Lake States Station — Forest Research in the United States. Prepared by Lake States Forest Experiment Station in cooperation with Committee on Forestry, National Research Council. (Mimeographed. November 1, 1938.)

Lake States Station	Forest Research Digest, Winter 1939. (multilithed. Lake States Forest Experiment Station.)
Lake States Station	Does Freezing Injure Planting Stock? Tech. Note 132, Lake States Forest Experiment Station, (Reprinted in Jour. For., December 1938.)
Lexen, Bert R.	An Experiment in the Use of Sodium Arsenite in Thinning Ponderosa Pine. (Journal of Forestry, March 1939.)
Little, Elbert L., Jr.	The Vegetation of the Caddo County Canyons, Oklahoma. (Ecology, January 1939.)
----------	A record of the Jaguarundi in Arizona. (Journal of Mammalogy. November 14, 1938.)
----------	Pteridophytes of Sierra Ancha, Arizona. (American Fern Journal. October-December 1938.)
Lorenzen, C., Jr.	Tests on use of compressed air in fire suppression. (Fire Control Notes, January 1939.)
Matthews, D. N.	Comments on "Sustained Yield Versus Clear-Cutting - A Hypothetical Case." (Journal of Forestry, March 1939.)
Matthews, D. N., and Campbell, J. F.	Region 6 fire-danger board. (Fire Control Notes, January 1939.)
Meagher, G. S.	Forest cover retards snow melting. (Jour. For., December 1938.)
Mirov, N. T.	Phylogenetic relations of Pinus jeffreyi and Pinus ponderosa. (Madrono, April 1938.)
Nelson, A. Z.	Comments on "Sustained Yield Versus Clear-Cutting - A Hypothetical Case." (Journal of Forestry, March 1939.)
Nelson, Mary L.	Preliminary investigations on dry, cold storage of southern pine seed. (Occasional Paper No. 78., December 8, 1938.)

Pearson, G. A.	Remodeling a forest with the CCC. (West Coast Lumberman. November 1938.)
Pessin, L. J.	Effect of the treatment of ground cover on the growth of longleaf pine seedlings. (Southern Forestry Notes, No. 25., January 1939.)
————	Root habits of longleaf pine and associated species. (Ecology, January 1939.)
Pessin, L. J.	Density of Stocking and Character of Ground Cover as Factors in Longleaf Pine Reproduction. (Journal of Forestry, March 1939.)
Rapraeger, E. F.	Development of Branches and Knots in Western White Pine. (Journal of Forestry, March 1939.)
Reynolds, R. R.	Possible Returns from Planted Loblolly Pine. (Journal of Forestry, March 1939.)
Schreiber, B. C.	Keys and charts for California species of Atriplex. (California Forest and Range Experiment Station. Technical Note No. 8.)
Shirley, Hardy L.	Comments. (On article "Some New Aspects of Seed Certification" by Henry I. Baldwin) (Jour. For., January 1939.)
Steer, Henry B.	Stumpage and Log Prices for the Calendar Year 1937. (Department of Agriculture Statistical Bulletin No. 66.)
Stoeckeler, J. H., and Bates, C. G.	"Shelterbelts: The Advantages of Porous Soils for Trees." (Journal of Forestry, March 1939.)
Wieslander, A. E., and Schreiber, B. C.	Notes on the genus Arctostaphylos. (Madrono, January 1939.) (Contribution No. 1 from the Vegetation Type Map Herbarium of the Forest Survey Division of the California Forest and Range Experiment Station.)

No. 335. The Theoretically Normal Composition of Selection Forests in Savoy. By T. Francois. From Revue des Eaux et Forets 76 (1); 1-18; (2) 101-115, 1938. Translated (French) by Viola Turgeau.

No. 336. Forestry Problems in the Industrial Forest During the Third Five-year Period). By I. S. Matiuk. From Forest Protection 1: 6-11. Goslestekhizdat, Moscow, 1938. Translated (Russian) by C. P. de Blumenthal, March 1938.

No. 337. Breeding of Forest Trees. By Ernst Rohmeder. From Forstwissenschaftliches Centralblatt 60 (4) 1938. Translated (German) by Michel Mok, April 1938.

No. 338. The Yarovization of Perennial Forest Plants. By S. A. Samofal. From Forest Protection, 1: 30-35, 1938. Translated (Russian) by C. P. de Blumenthal, March 1938.

No. 339. Thinning Hardwood Stands on Watersheds. By A. B. Zhukov. From V. Zashchitu Lessa (Forest Protection) 1: 16-23. 1938. Translated (Russian) by C. P. de Blumenthal, April 19381